The SCIENTIFIC MONTHLY

SUGGESTIONS FOR CONTRIBUTORS

These suggestions, if followed by authors, will serve to expedite the reviewing and processing of articles and to reduce appreciably the costs of processing and printing.

Every article, letter, or book review is accepted with the understanding that it has not been published or accepted for publication elsewhere. (Occasionally an important article is reprinted from another periodical, usually one not readily available to readers of *The Scientific Monthly,* but this is always done by special arrangement with the author.)

An article should receive a thorough review before submission, if possible by someone other than the author.

The manuscript should be submitted in duplicate. For the first copy, use a good grade of 8.5- by 11-in. nontransparent paper. *All copy, including quotations, footnotes, tables, literature references, and legends for figures, should be double-spaced.* Leave margins of at least 1.5 in. at the sides and at the top and bottom.

Illustrations. A brief legend should be provided for every diagram and photograph. It should *not* be incorporated in the figure. All legends are set in type by the printer and, hence, should be gathered together on a separate sheet.

On the margin or back of each illustration, write in pencil the number of the figure, name of the author, and abbreviated title of the article. All illustrations should be packed carefully with cardboard to avoid damage in mailing. Cracks and marks made by paper clips or pressure of writing ruin photographs for reproduction.

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Diagrams containing little detail should be planned so that the printed figure can be made one column wide or less. For presenting apparatus, particularly if it is complicated, a line drawing is usually better than a photograph.

If a graph is drawn on coordinate paper, the paper must be blue lined. Lines that are to be reproduced should be ruled over in black and made thinner than the lines of the curves and those of the frame.

Photographs should have a glossy finish. For satisfactory reproduction, a print must be unblurred and must show sharp contrast between light and dark areas.

Tables. Each table should be typed on a separate sheet and should be provided with a title. Tables should be numbered consecutively with Arabic numerals.

References and notes. To improve readability and reduce printing and processing costs, the following changes in style are now in effect with all newly received manuscripts.

The only footnotes are to be those appended to the title of the article, to the author's name, or to tables. All other explanatory notes, together with literature references, are to be numbered consecutively and placed at the end of the article, under the heading "References and Notes." These and other changes in style are illustrated by the following example:

References and Notes

1. W. C. Allee, *Science* **97,** 517 (1943).
2. The two sets of observations represent. . . .
3. A. K. Goodwon, *An Introduction to Ethics* (Myer Press, New York, ed. 2, 1949), p. 124.
4. This dimensional theory is more fully described in. . . .

We hope that readers will not be too impatient if mixtures of style occur in the next several issues. Articles already in type will not be altered.

Long ago a Roman schoolmaster named Quintilian advised authors to lay aside completed manuscripts long enough for them to seem like the work of others. The advice still holds good, for an occasional author could not tell me the meaning of certain sentences he had written a few months before. One denied the paternity of a "senseless" correction, and I had to show him the directions for it in his own handwriting. He had a distinguished forerunner in Robert Browning. Everyone is familiar with Browning's answer on being asked to explain an obscure passage in *Sordello*: "When I wrote that, God and I knew what it meant, but now God alone knows."—Eugene S. McCartney, "Does writing make an exact man?" *Science* **119,** 526 (Apr. 23, 1954).

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Index Issue

Cover: U.S. Geological Survey Plane
(Courtesy U.S. Geological Survey, see p. 364)

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Science and Technology

(From the month's news releases; publication here does not constitute endorsement.)

Pearl Spray

A pearl spray, packaged in an aerosol can, is designed to produce a mother-of-pearl finish on almost any surface, including cloth, glass, wood, leather, ceramics, paper, and metal. The spray is transparent, permitting the under color to show through. (Professional Art Products Co., Dept. SM, 845 S. Wabash Ave., Chicago 5, Ill.)

Portable Metal Band Saw

A portable, electric, metal-cutting band saw weighs only 16 lbs, is scarcely larger than a hand hack saw, and is 15 times faster by actual test. (Porter-Cable Machine Co., Dept. SM, 33 Exchange St., Syracuse 8, N. Y.)

Clinical Defibrillator

Instantly operative when turned on, this clinical defibrillator provides flexible facilities for direct application of electric shock to the ventricles of the heart in surgical cases involving ventricular fibrillation. The output of several amperes of 60 cy/sec alternating current is applied to stainless steel electrodes which are completely insulated except for their active faces. (Levinthal Electronic Products, Inc., Dept. SM, 2891 Fair Oaks Ave., Redwood City, Calif.)

Clinical Colorimeter

An advanced clinical colorimeter (Fig. 1), featuring a direct-reading meter, "pinpoint beam" optics, and simplified operation, achieves routine accuracies of ± 0.5 percent or better. The meter gives instant response, avoiding delays common to galvanometers and other indicators. (Beckman Instruments, Inc., Dept. SM, South Pasadena 1, Calif.)

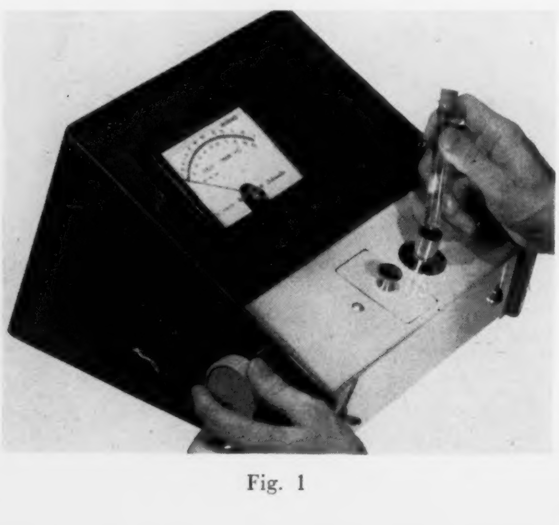

Fig. 1

Cam Clutch

A new line of cam-type, one-way clutch units, designed to serve as backstop (anti-rotation), indexing, and overrunning clutches in a wide variety of machine drives, are made with OD dimensions and tolerances corresponding to seven sizes of standard 200 series ball bearings. The clutches have no inner race; the full complement of cams bears directly on a hardened, shaft surface. (Morse Chain Company, Dept. SM, 7601 Central Ave., Detroit 10, Mich.)

High Strength, Non-Brittle Cement

A new type of cement has been developed to meet the need for a tough, non-brittle bond between pieces of FM-10001 nylon. This cement is a liquid chemical mixture that produces practically invisible joints. Its high fluidity permits rapid coating by dipping, brushing, spreading, or spraying. (The Polymer Corporation of Pennsylvania, Dept. SM, Reading, Pa.)

Heat-Shielding Suits

Heat-shielding suits, made of glass fibers and cloth, protect the worker who must operate in high-temperature areas. Lighter than conventional protective clothing, the garments have aluminized coatings which help to keep the wearers cool by reflecting heat. (Fyrepel Products, Inc., Dept. SM, Newark, Ohio.)

Oil Spray Gun

This pressurized oil can is a spray gun affair that blows a fine mist of light-weight machine oil on tools, toys, and sporting equipment to prevent rusting. The device also is useful in oiling things in hard-to-reach places. (Boyle-Midway, Inc., Dept. SM, Cranford, N. J.)

Airbrasive Unit

A new airbrasive unit can be used for precision cutting, drilling, etching, and light deburring on hard brittle materials. A selection of right-angle and straight nozzles with round and rectangular orifices is available for different cutting requirements. With the smallest nozzle, lines as fine as .008 inch can be cut, and cutting action is accomplished without the usual increase in temperature ordinarily experienced with other cutting methods. (S. S. White Industrial Division, Dept. SM, 10 E. 40th St., New York 16.)

Gas Volume Meter

A small, pocket-size, gas volume meter measures the volume of any gas passed through it. The instrument's accuracy is within 5 percent between the range of 5 to 65 liters flow rate per minute. (J. J. Monaghan Company, Inc., Dept. SM, 500 Alcott St., Denver, Colo.)

Analysis Set

A new density gradient analysis set makes it possible to establish rapidly and with extreme sensitivity the identity or non-identity of origin between two objects or materials. It provides for comparative analysis of glass, soils, safe insulation, sand, rock, mineral materials, and hair. (Microchemical Specialties Co., Dept. SM, 1834 University Ave., Berkeley 3, Calif.)

Burn Treatment

A handy, first-aid, burn treatment is packaged in small-sized, low-pressure spray units for dispensary and general emergency use. Said to provide pain relief and antiseptic qualities for burns of second and third degree nature, it is a non-oily material employing tannic acid, chlorobutanol, and benzalkonium chloride. (Spray Pack Products, Dept. SM, Cleveland, Ohio.)

Metal Comparator

A fast, accurate, non-destructive instrument for sorting mixed metal parts with varying alloy content is a portable device, easy to operate, and usable wherever it is necessary to distinguish one part from another with composition the only distinguishable feature. The comparator also can detect chills in castings, which cause hardness differences. (General Motors Corporation, Dept. SM, General Motors Bldg., Detroit 2, Mich.)

Map Measure with Magnetic Compass

This two-in-one map measure features a built-in magnetic compass on the reverse side. The map measure has an inches-to-miles and a centimeter-to-kilometer dial. A small wheel on the bottom of the unit allows you to trace along the desired route and obtain an instantaneous reading in inches from the dial. Multiply this dial reading by the mile-per-inch factor of the map and you have the distance in miles. (Selsi Company Inc., Dept. SM, 29 E. 22nd St., New York 10.)

Remote Handling Tongs

The pistol handle of these remote handling tongs gives a good comfortable grip with either the "scissor" or "monkey wrench" type jaw and any of the three interchangeable shafts. The double "scissor" jaw is particularly adapted for handling small and large vessels. The "monkey wrench" jaw will grip heavier objects with equal facility. Either jaw can be locked into a fixed position for very heavy objects by tightening the knurled nut on top of the pistol handle with thumb and forefinger. (Instruments & Equipment, Inc., Dept. SM, 489 Fifth Ave., New York 17.)

Redesigned Electric Stopwatch

A redesigned electric stopwatch provides greater accuracy in laboratory work where precise, split-second timing is a must. Timing as accurate as the cycle frequency of your electric current makes this ideal timer for radioactivity counting systems, as well as for ordinary laboratory uses. (Precision Scientific Company, Dept. SM, 3737 W. Cortland St., Chicago 47, Ill.)

Marking Device

A new marking device writes with a felt nib, makes lines of varied widths from pen-stroke to brush-stroke size, and comes in the six primary colors plus black, brown, and white. The ink writes on any surface, porous and non-porous, and its markings are completely wear-proof and waterproof. It dries as fast as you write and is impervious to heat and cold. (Speedry Products, Inc., Dept. SM, 91-31 121st St., Richmond Hill 18, N.Y.)

Liquid Sample Attachment

A liquid sample attachment, one of the most sensitive instruments used in the measurement of gamma emitting liquids, was designed for counting very low level activity in small volume liquid samples (up to 5 cc). The estimated efficiency for a small sample of I-131 is 50% of all gamma rays emitted. (Nuclear Research and Development, Inc., Dept. SM, 6425 Etzel Ave., St. Louis 14, Mo.)

Metals Detector with Built-in Battery Tester

An electronic metals detector with built-in battery tester enables operator to test each individual battery, thus providing accurate knowledge of the condition of the power supply at all times. A substantially increased range of detection is also embodied in this instrument. (Gardiner Electronics Co., Dept. SM, 2018 N. Dayton, Phoenix, Ariz.)

Polishing Stand

A portable polishing stand (Fig. 2), designed to eliminate difficulties experienced when attaching and holding flat any optical polishing paper on a metal plate, has been primarily developed for polishing work pieces for inspection during surface grinding or lapping operation in laboratories, or on small run polishing jobs. It eliminates the need to check plate for flatness and time spent in re-lapping. (Crane Packing Company, Dept. SEW-SM, 1800 Belle Plaine Ave., Chicago, Ill.)

Fig. 2

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Geology and Health

HARRY V. WARREN*

Dr. Warren received his B.A. from the University of British Columbia and has been in the Department of Geology and Geography there since 1932. During 1926–1929, he was a Rhodes scholar at Oxford University, where he received his Ph.D. in 1929. Dr. Warren has done work on the lead and zinc deposits in southwestern Europe, on grunerite in the high Pyrenees, and on gold, silver, and strategic minerals in the Pacific Northwest. In addition to his university duties, he is a consulting geological engineer and president of the British Columbia and Yukon Chamber of Mines.

MARK TWAIN'S often quoted remark about the weather, "everybody talks about it but nobody does anything," could not truthfully be paraphrased about health. Everybody directly or indirectly, knowingly or unknowingly, is concerned about health. Nearly everyone talks about health. It provides the opening gambit of conversation for most people. "How do you do?" by familiarity may have become almost meaningless to some, but to many it opens the doors to a world of interesting discussion.

However, if man is failing to do much about the weather, he is certainly attempting to do something about his health. Thousands of the world's best brains are trying to find solutions to the problems that are endangering the health of man. Millions of dollars are being poured into studies, often, alas, with little regard to their comparative importance. All these studies are aimed at making us healthier and, it is to be hoped, happier.

* The author would like to express his thanks to the many persons and especially his university colleagues, particularly Dr. R. E. Delavault, who have directly or indirectly helped in the preparation of this paper. Few will subscribe to all the ideas discussed and not all may agree with the conclusions, but by discussions they have tried to educate the author and at least have succeeded in stimulating him.

Already there may be many engaged in research on health problems who might better be engaged elsewhere. Nevertheless, this paper presents a plea for yet one more group to enter the field of health studies, namely, the geologists. By himself, the geologist may not be able to offer a great deal that will improve the health of the world but, as a team member, it would seem that he has much to contribute. These remarks are intended to support the theme that many committees whose duty and privilege it is to direct attacks on problems of health could, to the advantage of all concerned, invite a geologist to deliberate with them. Some years ago I was invited to sit on the Committee of the British Columbia Cancer Society. The experience was interesting, challenging, and at least not more time-consuming than many of the other less-rewarding committees on which scientists are likely to find themselves if they are connected with a university.

Development of Present-Day Life

Whatever form of creation is favored by the reader and irrespective of his general beliefs with respect to evolution, he would doubtless be prepared to accept the fact that most of the life of the world as we know it today evolved from marine

life, the earliest records of which go back some 500 million years into the past. Some biologists have gone to some trouble to point out how even today there are remarkable parallels between the mineral contents of some mammalian blood and the blood of some marine animals, such as the king crab. Be that as it may, man in something like his present form has lived on this planet for many thousands of years, congregating in those areas where the prospects of obtaining food supplies were at least reasonably propitious.

Because energy as he knew it consisted of that supplied by human beings and a comparatively few animals, ancient man did not travel widely. With comparatively few exceptions, he lived close to his supply of food. Man simply did not have the energy to transport food great distances; a few luxuries perhaps, but not much even of these. If the food supply were not adequate for a given population, that population lessened, moved on, or died out. That would have been the time for studies connected with the geography of health to have been undertaken!

Primitive man probably had quite enough complications in his life without knowing the contribution that food was making to his calorific, mineral, and vitamin needs. Actually, without realizing it, early man just happened to insure himself a reasonably good supply of minerals. He lived on or near the deltas of great rivers, which actually were the foundation for his granaries. The river deltas were made up of rock and mineral particles derived from vast areas of hinterland; moreover, the floods not only tended to remove those with less favor in the eyes of the gods but they also added new mineral bounty all through the ages of which we have any record. Naturally, these floods did not guarantee mineral health because, as we know now, there are whole regions of the earth's crust that may be low to the point of actual deficiency in some elements. Nevertheless, in a crude way man was getting his mineral needs without any of the complications caused by the use of artificial or synthetic fertilizers. Even so, it will be remembered that there were large portions of our globe that seemed capable of supporting only an extremely modest number of persons. Then again, some areas that seemingly had supported considerable populations were, if our interpretations are correct, suddenly left without any population whatsoever. Many explanations have been offered for these comparatively sudden disappearances of population. Few, if any, have been proved. Perhaps one more suggestion might be in order. Possibly the running short of some vital trace element might have killed off some populations. After all, most people alive today, even if they were not aware of it, have seen large sections of the sheep population of the world faced with extermination because of a lack of one element, cobalt, which is needed in a sheep's diet only to the amount of something of the order of one part in a million. Even those who have not read Bret Harte's *M'Liss* probably are aware of how, until recently, apparently it was impossible for the inhabitants of an area in which arsenic was an integral part of the local diet to move away from that area and live. Without that minute trace of arsenic they died. Recently a report has come from Central Africa of an explored area from which no animal seems able to depart and live. However, all this is interesting speculation.

Trace Elements

A few more words about trace elements should be of interest. It is well known that 15 elements comprise more than 90 percent of the earth's crust, and these elements—oxygen, silicon, aluminum, iron, calcium, magnesium, hydrogen, titanium, chlorine, phosphorus, manganese, carbon, sulfur, nitrogen, and fluorine—have for many decades appeared in analyses, including variously those of rocks, soils, and biological material.

Most of the other elements occur only in such amounts that, when routine analyses were made on a few grams of rocks, soil, or biological material, they were at best reported to be present as a "trace." Today it is common for a reasonably accurate zinc determination to be made on a decigram of plant containing only from 20 to 50 parts per million of zinc in a dried sample. Under special circumstances, more notable results are possible. In our own laboratories, where until recently we were primarily engaged in prospecting work, we regularly determine by chemical means molybdenum concentrations as low as 1 part in 10 million on 2-gram samples. As analytical techniques have improved, so has our realization of the importance of various trace elements in biological processes. A study of enzymes has shown that in a pure state they contain amounts of the order of one atom per molecule of such elements as zinc, copper, molybdenum, and cobalt.

Many of these trace elements are now known to play an important and even vital part in the growth of organisms ranging from *Penicillium* to human tissue. The growth of bacteria can be influenced by the amount of specific trace elements present in a culture. Agricultural land in New Zealand has been brought under cultivation with the aid of an addition of as little as 2 ounces of molybdenum per acre. In Australia, research has

shown that, in an area of more than 1 million acres, by adding for each acre 7 pounds of zinc and copper sulfate to the usual superphosphate fertilizer, land that was practically hopeless agriculturally can be made to support three and even four sheep to the acre.

Even forest growth can be vitally affected by trace elements. The Saturday Magazine Section of the *Christian Science Monitor* of September 11, 1948, described one of the most interesting examples of this relationship. In this article it was described how early attempts to grow *Pinus pinaster* at Gnangara, a sand plain plantation, failed. After evolving a method of inexpensively and effectively adding zinc, in addition to phosphate, to the soil, some 3000 acres of *Pinus pinaster* were maintained on a commercial basis. Without fertilizing, trees would not exceed 3 to 4 feet in height, but with trace elements added they attained measurements up to 50 feet, together with commensurate general development.

Interesting though the aforementioned examples may be, they are matched if not exceeded by those even more directly affecting the health of animals and human beings.

In a report to the American Public Health Association ("Carcinogenicity vs. toxicity" in the November 30, 1953, issue of *Chemical and Engineering News*) W. C. Hueper of the National Cancer Institute is reported as saying: "Beryllium has caused bronchiolar cancers in rats . . . ; arsenic cancers of the skin have been found among arsenic miners and smelter workers . . . and among consumers of wine where grapes are sprayed with arsenical insecticides . . . ; lung cancer has killed from 75 to 80% of miners in radioactive cobalt mines in Schneeberg and 40 to 50% of uranium miners in Joachimsthal."

Dr. W. C. Gibson, of the University of British Columbia Faculty of Medicine, recently showed me data on Norway which indicates that the incidence of multiple sclerosis is 10 times as great in some parts of the country as in others. No doubt, many reasons have been advanced for this variation: diet almost certainly would be one. The relationship between the incidence of multiple sclerosis, diet, and geological background in Norway, if it has not already been investigated, would seem to offer a fruitful field of research for some team of scientists.

Not only excesses of trace elements but also deficiencies of them may cause trouble in animals and human beings. It has long been recognized that a lack of iodine causes goiter in both human beings and animals. Dr. W. D. Keith as far back as April, 1924, published an article in the *Canadian Medical Association Journal* on "Endemic Goitre." He pointed out how British Columbia, like all mountainous countries, is peculiarly liable to goiter and how one agricultural area, the Pemberton Valley, was about to be evacuated when goiter and the inability of pigs, cows, and even chickens to reproduce was proving disasterous. A correct diagnosis of iodine deficiency enabled the troubles to be overcome merely by administering iodine, but not before Dr. Keith was able to make some useful and potentially very valuable observations, some of which may be worth noting.

"Many of the cows, mothers of the goitrous calves, carried their offspring ten months, i.e., a month longer than usual. . . . Mares after coming into the valley developed goitre, and after being in the district three years their colts were goitrous. The second colts gave some evidence of myxoedema, but lived. These colts instead of the usual eleven months were carried 12 and sometimes 13 months. In all cases where the colts were carried 12 or 13 months they were weak goitrous, and did not survive."

In a small Indian village at the lower end of the valley where no sanitation had ever been attempted, neither the Indians nor their pigs were bothered by goiter. Dr. Keith was able to show that salmon, enjoyed by pigs and men alike, provided the necessary quantum of iodine.

Doubtless, many other examples could be quoted of known relationships between trace elements and plants and animals. However, enough evidence has been given to indicate that, as our knowledge of trace elements advances and, particularly, our analytical techniques for studying them quantitatively, we may expect significant discoveries to be made in the relationships that must exist between trace elements and health.

Let us pass on to an examination of what has happened in the last few years, geologically speaking, of man's stay on earth.

Major Changes in Our "Modern World"

Three major changes have taken place which collectively may well alter the relationships between man and the mineral portion of his food supply. First and most obvious, but not necessarily most important, the world's population has increased from some 500 million to nearly 2500 million in the period between 1650 and 1950.

Second, thanks to his recent successes in using energy, man is now able to grow foodstuffs in many parts of the world where he was not able to do so before. Moreover, thanks to improvements in transportation, he is able to transport these foods to the four corners of the globe. On first sight, this

is all to the good: indeed on balance it probably remains one of the greatest achievements of man. Nevertheless, two aspects of this development must be considered. Food is now being grown on and removed from areas that differ widely in their geological background and, consequently, in their trace-element content. Furthermore, it is being grown in many areas that cannot look forward to any natural replenishing of their mineral supply by floods as could the ancient breadbasket of the Nile and Ganges deltas. We have good examples of what this means already. The great dams on the Nile and the Colorado rivers have built artificial lakes behind them. In these artificial lakes the silt has fallen so that the irrigation water resulting from these rivers below their dams has not provided the mineral nutrients that it did formerly, and today increasing amounts of artificially prepared fertilizers are necessary to maintain the fertility of these areas. All this can perhaps be claimed as progress, and it would be foolish to say that it is bad. Nevertheless, the point that must be made is that complications may arise out of all this development, and not least are the complications brought about by a changing pattern in the trace-element content of some of our basic foodstuff.

Third, and not always remembered, is the fact that today we are no longer taking from the earth and returning to the earth its gifts of minerals. Today great sections of the world are congregating in urban areas and disposing of their waste by dumping it into oceans, lakes, and rivers—not back onto the land. Vegetation along our lakes and streams does unspectacular but useful work in places by absorbing metals from the water and holding it for the land. However, at present the earth seems to be playing a losing game to the sea which on balance would seem to be becoming richer and richer in many minerals. Could it be that the craving for sea food claimed by some people actually has a sound background?

In short, there are 5 times as many people in the world today as there were 300 years ago. They are eating foods from many new areas from which they never had food before, and in which we are only now beginning to appreciate the difficulty of maintaining their appropriate mineral content. Finally, we are taking more and more of our little understood trace elements from the land and throwing them into the sea. Of fundamental importance is the fact that, while life has been evolving for perhaps 500 million years or more, all these changes have come about in the last 300 years. It would be a strange coincidence if some adjustments did not have to be made somewhere.

Against all these facts is one that so far has almost certainly worked for man, or at least for the people blessed with better than average standards of living. Many people are today eating food from such a variety of sources that it is unlikely that many can actually be suffering from a deficiency of any element. Nevertheless, the possibility remains. After all, with some 2500 million persons on this globe, it would surely be almost uncanny if an appreciable number did not find themselves with too little or too much of some element, especially when so many of our comparatively "well to do" apparently do their best to make deficiencies possible by eating so much refined food such as white bread and sugar.

A Review of Food Thinking

During the past few decades we have had three well-marked phases of thinking about our foods. These were by no means mutually exclusive, but each had its day and now all have more or less become incorporated in our general thinking. Perhaps these might be thought of as the age of minerals, the age of calories, and the age of vitamins. At one stage, lime and phosphorus for bone and muscle were all the rage, and every prudent mother fed her baby limewater, if lime was not abundant in the food or water of the area. Then came the "calorie age," which is being so effectively revived by the newspapers in their "Tubby-hubby" and related campaigns. Then came the age of vitamins when we all learned why milk and vegetables were good for us and cod-liver oil was substituted for sunshine, often kept from our great cities by smog and latitude, neither of which can be coped with effectively.

Dean Blythe Eagles, of the University of British Columbia, has suggested that our next phase may well be that of the trace elements. After all, why not? We will merely be going back to where we left off not so very long ago, only now we have many new tools and perhaps a little more experience than we had then. Today it is generally conceded that together trace elements and vitamins, if linked with essential protein, acquire enzymic properties, which are responsible for the carrying on of many life processes. In other words, the metabolism of a living cell is related to many factors, among which are the trace elements.

The Origin of Soils

Agriculturists know better than most that the mineral content of foods is dependent on the mineral content of the soil whence the food originated. Soils, in turn, are largely the production of the climate, topography, and vegetation acting on

a particular portion of the earth's crust that is composed of some particular rock or rocks. The rocks of the earth's crust differ widely, both in the proportions of their more abundant elements and in their trace-element contents. So far, most investigations have dealt with the more abundant elements in foods and soils and their effects on mankind. However, insufficient attention has been paid to one fundamental fact, namely, that the quantities not only of the abundant but also of the trace elements in a soil are primarily determined by their original presence in some rock. Climate, because it is a modifying and obvious agent, has possibly been given, quite naturally, more than its share of the responsibility of determining the mineral content of soils. Actually, a second fundamental fact, which must not be overlooked, is that climate, irrespective of what it can and does accomplish in the way of modification, can in essence only subtract an element or elements from a soil. It cannot, except for relatively minor exceptions, add an element not present in the parent material.

As far as we have been able to ascertain, few, if any, investigations have been made on the relationships that must exist between the trace-element content of cereals and other important primary foodstuffs and their geological backgrounds.

Laboratory Evidence of Possible Significance of Trace Elements

In our own biogeochemical laboratories, we have obtained much evidence to indicate just how vital trace-element geology relationships may prove to be. We have found that apparently healthy and normal Douglas fir (*Pseudotsuga taxifolia*) varies greatly in its manganese and iron content, depending on the rock on which it may be growing. We have shown that some "sterile" sands sold for plant experiments contained in fact appreciable amounts of such elements as boron, calcium, and potash. We have demonstrated that many chemicals, supposedly free of heavy metal, prepared for bacteriological experiments do in fact contain sufficient trace elements to make it necessary to question the validity of many "controlled" experiments. We have discovered in blood larger quantities of silver than we have found indicated in at least the more generally accepted references. We have made some comparatively primitive investigations which have satisfied us that barley from different areas contains different amounts of some trace elements. These variations suggest the desirability of seeing if they can be correlated with variations in enzyme reactions that are encountered when the malting qualities of barley are investigated. We have also demonstrated, to our own satisfaction at least, that virtually all forms of life contain, respond to, and are affected by virtually all these elements that we have been able to investigate, including not only such elements as molybdenum and cobalt but also some such as cadmium, nickel, silver, and gold whose relationship to nutrition has been little investigated.

Regional Development Shows Response to Trace Elements

It is a recognized fact that until comparatively recent times when man upset the orderly development of life by developing on a major scale transportation, sewage disposal, and artificial fertilizers, each form of life tended to develop with some relationship to its geological and geographical background. In some areas the natives had good teeth, in others bad. In some areas, there was endemic anemia; in others, goiter was prevalent. In still other areas, the bones of people and the shells of eggs were noted for their brittle quality. All these peculiarities are now related, among other things, to a surplus or deficiency in "appropriate amounts" of such elements as fluorine, iron, iodine, and calcium.

However, these elements have been present, for the most part, in amounts ranging from 1 part in 100 to as little as 1 part in 1 million. Very little has been done to study the distribution and effect of these elements that are present in biological samples only in amounts of the order of 1 part in 100 million.

Trace Elements, Geology, and Disease

Today many investigations are being made on the geography of disease. Cancer and multiple sclerosis are two major problems with which scientists are confronted, and present-day thought seems to be turning to the belief that the solution to these diseases and possibly others lies in biochemical processes. The biochemical and geographical aspects of these diseases are worthy of attention, but surely these studies should also include the most fundamental aspect of all, the ultimate source of the trace elements, the rocks.

In short, we believe that it would be a useful and fruitful study to investigate the trace-element content of some key food products with particular reference to their geological and pedological background. We would like to do on a major scale the sort of thing that Mitchell, of the Macauley Institute in Scotland, has done so grandly on a more modest scale.

A Plan of Campaign

There are several methods of opening an attack on the relationship between trace-element geology and health. Two appear susceptible of parallel development. In the first, agriculturists and geologists would select some parts of the world where cereals could be collected from areas underlaid by typical rock formations of various types. In these same areas, botanical collections of typical and marginal flora would also be made. All these samples would then be analyzed by suitable techniques, such as are now being employed in biogeochemical laboratories. For example, it is now known that some areas of British Columbia are woefully deficient in zinc and others in boron. These deficiencies may be discovered by soil analyses, by empirical tests, or by making comparisons between the mineral content of some trees or lesser plants common to numerous areas. Actually, when one considers all the complications arising from the inherent difficulties attendant on determining the relationship between the total amount of an element in any given soil and the amount of that element available to a given plant, the last-named scheme would seem to have much to commend it. A second method would be to have a committee of medical men, agriculturists, and geologists consider specific areas of the world where specific ailments are more or less endemic and where they might be related to some mineral factor, as is the case with goiter and iodine. The geologists and agriculturists would then determine which of these areas produce foodstuffs susceptible of being investigated for abnormal amounts of trace elements by the biogeochemical methods now available.

By combining these two methods of attack, it should be possible not only to set up "normal" trace-element contents for some key foodstuffs growing under specific conditions but also to discover the type and nature of the anomalies that may be related to various problems of health and nutrition.

The following instance affords a typical example of the type of correlation that might be expected when regional studies of trace elements are made by a team of experts.

Until a couple of years ago, molybdenum was considered a poison, and surpluses in vegetation were correlated with a cattle disease. Recently, work in Florida on grapefruit has revealed that a virus-like disease in these plants has been caused by a molybdenum deficiency, which after correct diagnosis was speedily corrected. In British Columbia, we have found that in some areas mountain fir (*Abies lasiocarpa*) carries less than 0.1 part per million of molybdenum in dry needles, whereas only 100 miles away needles from the same species contain upward of 50 parts per million. Thus, in one geographic area, there is a variation of at least 500 times the molybdenum content in one species of tree. Mr. Carl Bischoff, of Rouyn, reports comparable variations in alder trees of eastern Canada. Both alder and mountain fir are important sources of food for moose. Molybdenum appears to assume added importance, over its essential part in nitrogen fixation by bacteria, because The Nutrition Foundation has recently announced (*Chemical and Engineering News*, November 30, 1953, p. 4972) that it is an "essential part of a catalyst present in animal liver cells (xanthine oxidase), where it functions in nitrogen (nucleic acid) metabolism." Thus, molybdenum is involved both in the growth of at least some forms of vegetation and in the use of energy by animals. Apparently, either too little or too much can be fatal to animals.

Probably, it would be wise to probe on both fronts and learn, if possible, something of both the normal and abnormal trace-element contents of reasonably large and representative suites of samples of a few selected foodstuffs. At all events, the success of any program will depend on the cooperation of a team of competent men. If possible, they should work in cooperation with the World Health Organization and other appropriate United Nations organizations. Specialists in at least the following fields should be on any team attacking this problem: pedology, biochemistry, pathology, physiology, botany, geology, geochemistry, biophysics, chemistry, physics, microbiology, geography, cartography, neurology, and statistics. Actually, it will not be easy to assemble and get a team of this sort working effectively. However, the need is great and an operation "trace elements and health" is worth undertaking.

Whatever methods of attack are used, the project would involve analyzing many samples, not only for their more obvious mineral content, but also for their trace elements. The results obtained should then be presented for correlation with their pedological, geographical, and geological backgrounds. These findings would then be distributed to the medical men and they, in turn, would evaluate the results and see if they were susceptible to medical interpretation.

The Need for Teamwork

In putting forward this idea, which must seem almost naïve in its simplicity, I would like to make these observations. Few geologists have ever de-

voted themselves to thinking out the implications of their science on the health of man. Few physicians have sufficient geological background for them to have investigated the effects of geology on nutrition. Agronomists are probably best aware of the relationship between geology, soils, and plant health, but few appear to have had an opportunity of delving into the medical significance of trace elements. Physicians have relied on their own general knowledge of geography, and on geographers, for most of their medical studies of the geography of disease. Geographers have tended in recent years to be more interested in exploration than in scientific investigations, more concerned in furnishing data to scientists than in instigating new researches and, therefore, in my opinion, are not likely to provide a scientific link between the medical investigator on the one hand and the pedologist and geologist on the other.

To sum up, surely a study of trace-element variations in some important foodstuffs and the relationship between these variations and the pedology, geography, and geology of the background of these foodstuffs would be an original and useful contribution and might well prove to have fundamental significance to the health and welfare of man.

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The Piltdown story is a significant one in the history of ideas, more particularly as it bears on the concept of the precise course of human evolution. For, if man's biological history be likened to a book, it is seen to be composed of both blank and written pages and, by those who note them carefully, many if not most of the written ones will be seen to be in the nature of palimpsests—pages that have been rewritten after their original writing has been rubbed out. Of this, the Piltdown affair is a striking demonstration. It is a demonstration, furthermore, that the palimpsest nature of the pages of man's history is not always due directly to new fossil discoveries but can also result from changes in the philosophical climate of the science. That this phenomenon is peculiar to anthropology, however, is seriously to be doubted.—William L. Straus, Jr., "The great Piltdown hoax," *Science* **119**, 268 (Feb. 26, 1954).

The Colorado Plateau Province as a Field for Geological Survey Study

MARY C. RABBITT

Mrs. Rabbitt is a member of the staff of the U.S. Geological Survey. She pre- prepared this article on the occasion of the 75th anniversary of the Survey to show some of the varied activities carried on by this agency in the pursuit of its work. Source material has been drawn from many reports of the Survey, and all photographs are from Survey files. Advice and assistance were received from colleagues too numerous to mention individually.

THE Colorado Plateau Province is an area of some 125,000 mi² in southeastern Utah, northern Arizona, northwestern New Mexico, and southwestern Colorado (see map on opposite page). Nearly the whole area is drained by the Colorado River and comprises about one-half of the entire drainage basin of the river.

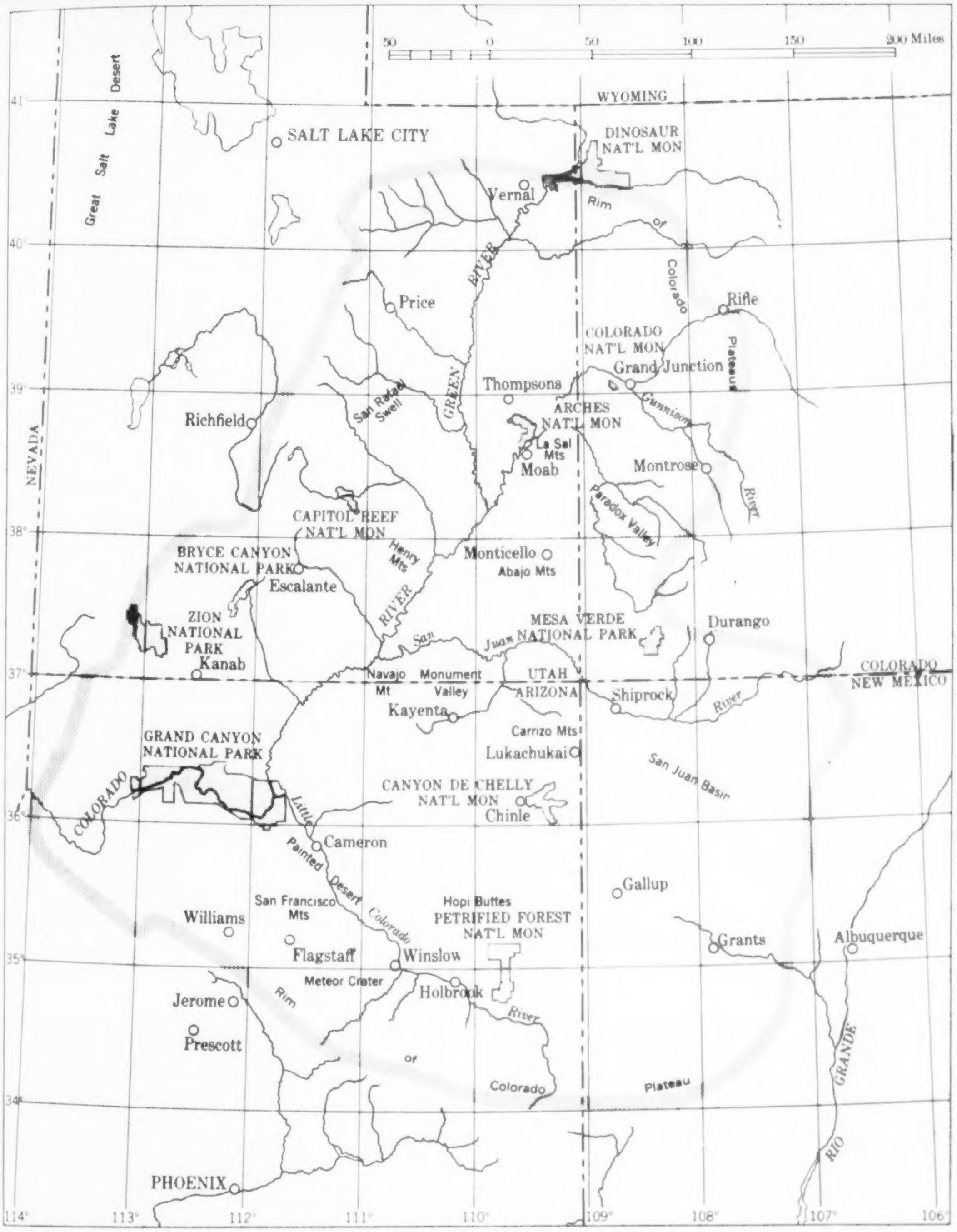
It is a region that is interesting scenically, historically, and economically. Within its borders are such spectacular sights as the Grand Canyon of the Colorado, Bryce Canyon, Zion Canyon, Monument Valley, the Natural Bridges, the Painted Desert. There are deeply cut canyons, broad tablelands, and strong color everywhere. It is the country of Coronado and Anza and Escalante, of Jim Bridger, Jedediah Smith, and Bill Williams. Much of the Colorado Plateau Province is desert land, but there are many fertile valleys and extensive timberlands and stock ranges. It is an area of tremendous potential for water-power development and irrigation and is also a region of considerable mineral wealth. We tend to think first of uranium nowadays, but one of the most developed resources is coal, and there are also deposits of oil, potash, salt, gypsum, pumice, semiprecious stones, vanadium, copper, lead, manganese, and gold. Resources of oil shale are tremendous, and there are reserves of the gases helium and carbon dioxide and the hydrocarbon gilsonite as well.

The Colorado Plateau Province is also a region of great geologic interest, and has been ever since the days of the early surveys under Powell, Hayden, and King. Writing under a similar title in the *American Journal of Science* in 1876, 3 years before the establishment of the United States Geological Survey, G. K. Gilbert pointed out that

> As a field for the studies of the geologist, the Plateau province offers valuable *matter* in an advantageous *manner*. . . . The exposure of rock structure in the Colorado Plateau province is exceptionally thorough. . . . The rock structure is simple but not the simplest. . . . In virtue of the simplicity of structure and continuity of exposure, the geologist does not have to put fragmentary data together and grope for the general facts of which they form a part, but is able to see all the parts combined in nature in visible wholes. Nothing need be left for doubtful interpretation where everything can be seen; and with the facts of structure conspicuous and beyond question, the mind is left free to search for causes.

Studies of simple displacements, eruptive mountains, stratigraphy, and erosion in this area would, he felt, contribute "to the body of principles which constitute the science of geology" rather than "merely enlarge the body of facts upon which its established principles are based."

When the Geological Survey was organized in 1879, the country west of the 101st meridian was divided into four "geological fields," each of which became the province of study of a Survey division. One of these was the Division of the Colorado under Captain C. E. Dutton. It was noted in the first Annual Report of the Director, however, that the division had been for 12 or 13 years the field of exploration of Major Powell, whose extensive work had been inherited by the Survey, and that the Division of the Colorado would therefore be only a temporary one until this work, already far advanced, could be brought to completion.



The name "Colorado Plateau" was first used in Lt. Ives' Colorado River report in 1861 for the area between the San Francisco Mountains and the Grand Canyon. Later usage extended the term to include the broad upland through which the Colorado has excavated its deep channel; and finally, as the minor plateaus of which the great one is composed began to be discriminated and named, the comprehensive title of the whole became the Colorado Plateaus or the Colorado Plateau Province.

The Major's work has not yet been finished. New problems, in part the outgrowth of new concepts, and new needs have kept the Geological Survey actively studying the Colorado Plateau Province even to the present day.

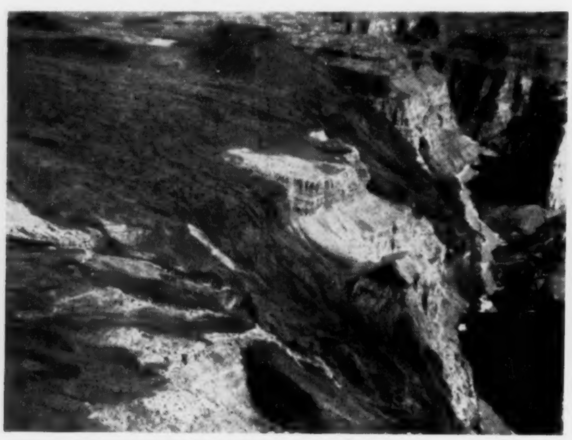
During these 75 years, the Geological Survey has made extensive studies and published reports on the geologic structure and stratigraphy of many parts of the Plateaus, and has investigated and reported on a variety of mineral resources. The coal

(Left) Salt Valley anticline, Grand County, Utah. Resistant beds of sandstone form ridges up to 40 ft high on the flanks of the anticline. Large areas of the Paradox formation, which contains gypsum and salt, are exposed in the Valley. This photograph and the others on this page were taken from the Survey plane shown on the cover. (Right) Comb Ridge, Utah, is part of one of the most remarkable monoclines in the Colorado Plateau Province. The ridge extends for more than 100 mi and rises so abruptly that it can be crossed in only a few places. During the summer of 1953, several young Survey geologists were trained in mapping techniques in this area.

deposits, the oil shales, the potash deposits, the oil and gas possibilities, and gypsum, carnotite, copper, and vanadium deposits, among others, have all been described in Survey reports. Facts have been developed on the water supply of the principal rivers to permit planning the maximum practical utilization of power, preservation of water for irrigation, elimination of the flood menace, and solution of the silt problem. The ground-water resources of many parts of the Plateaus have been studied, but much still remains to be learned about this valuable resource.

The Survey has also had the responsibility, by its charter and various mineral-leasing acts, of classifying Federal lands according to mineral and water resources, and of supervising all operations concerned with the exploration and development of mineral resources on Federal and Indian lands. Field surveys are made; maps and reports are prepared on water power, fuels, minerals, and chemicals essential to the economy of the United States; mining and drilling operations are supervised on the site to assure the safe and efficient production by private enterprise of coal, oil, gas, and other minerals. During the year 1953, nearly 41 million dollars in royalties accrued to the Federal and state governments from such operations.

Much of the intensive geologic activity on the Plateaus today results from the fact that, in 1899, a yellowish material long known in the sandstones



(Left) Western end of the Grand Canyon of the Colorado, Arizona. Lava flows spilling over the rim and a cinder cone are in the background. Geologic studies of the Canyon were made in the early days of the Geological Survey. (Right) Book Cliffs, near Grand Junction, Colorado. The valley at the foot of this escarpment is several miles wide here and is a large fruit-growing center. The Book Cliffs extend westward into Utah for a considerable distance. Coal-bearing beds crop out in the cliffs and have been investigated by Survey geologists.

of Montrose County, Colorado, was found to contain uranium and vanadium. The mineral was described and named carnotite by the French mineralogists Friedel and Cumenge, who had received a sample from Charles Poulot, a French engineer residing in Denver. A year later, Hillebrand and Ransome, of the Geological Survey, reported additional information on the Colorado deposits. The deposits were of immediate interest and were mined chiefly for radium, which the Curies had succeeded in isolating from uranium in 1898. After the discovery of the Belgian Congo deposits in 1923, mining operations ceased. They were resumed in 1937, but for vanadium, which was needed for special steel alloys. In recent years, of course, interest has centered on the uranium content of the deposits.

In the search for new sources of uranium, as well as for other mineral and water resources, the primary function of the Geological Survey is one of supplying the basic data upon which intelligent programs of exploration and exploitation can be based. In developing these basic data, the Survey makes use of its wide variety of scientific and engineering skills in integrated investigations. In the Colorado Plateaus, the Survey is now carrying on, in large part on behalf of the Atomic Energy Commission, a broad program of geologic mapping, stratigraphic studies, geophysical surveys, geobotanical, mineralogic, and ground-water investigations, and resource appraisals. Topographic mapping at large scales is progressing at an accelerated pace. In addition, a program of fundamental research in the geochemistry of Plateau ores is under way.

Geologic mapping projects are aimed at appraising the ore deposits in the chief uranium-bearing formations. Two types of mapping are done: in areas where an adequate geologic map already exists, a detailed map of the ore-bearing beds and adjacent strata is prepared; in other areas, the detailed mapping is extended to the boundaries of quadrangles as a step toward complete understanding of the geology of the region.

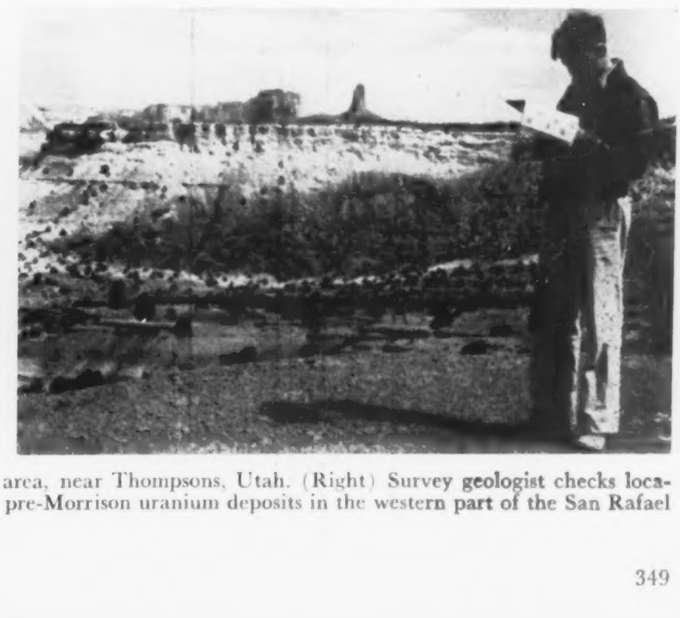
Photogeologic mapping, that is, the compilation of a geologic map from aerial photographs, provides regional geologic maps until more detailed ground surveys can be made.

Stratigraphic studies of the ore-bearing formations provide information on the distribution, local and regional variations in lithology, source of the material, conditions of deposition, and postdepositional history.

Geophysical surveys are made in conjunction with geologic studies to provide additional subsurface data and also in an attempt to develop geophysical prospecting methods as an aid to exploration for uranium deposits. Seismic, gravimetric, magnetic, and electric resistivity and self-potential methods have all been used.

Regional geophysical surveys are being made of the northern part of the Plateau Province in an attempt to define as completely as possible regional structural trends, buried intrusive rocks, and changes in composition in the basement rocks or in the relief of the basement surface, and to determine whether any relationship exists between these features and the uranium deposits. The picture on the cover shows one of the Survey planes engaged in such a survey.

Ground-water studies have been aimed at determining the transmissibility characteristics of the sedimentary formations on the Plateaus and to de-



(Left) Plane table mapping in the Yellow Cat area, near Thompsons, Utah. (Right) Survey geologist checks location on map while on regional reconnaissance of pre-Morrison uranium deposits in the western part of the San Rafael Swell, Utah.

Survey geologist "rim walking" and examining the numerous mine workings in the vicinity of Temple Mountains, San Rafael Swell, Utah.

Geobotanists get ready for work north of Black Box Canyon, Emery County, Utah. This is an area of indicator plants. Mapping of the distribution of indicator plants may delineate favorable areas for the occurrence of ore. In areas where the absorber plant method is used, plant material is systematically collected and analyzed. An experimental garden has also been established to study the absorption of uranium in plants.

termine the structural features that may have served as channels for the introduction of the ore-bearing solutions.

Geobotanical prospecting has been successfully used in exploration for uranium. Some deep-rooted trees growing above shallow, concealed deposits absorb and accumulate anomalous amounts of uranium which can be detected in the branch tips. Certain plants tolerate or need relatively high concentrations of specific elements. In the Colorado Plateaus, selenium and sulfur are commonly associated with the uranium ores, and characteristic selenium- or sulfur-requiring flora have been used as a guide to uranium deposits.

Since 1948, the Geological Survey has been investigating the use of gamma-ray logging techniques in small-diameter drill holes, both as a means of making quantitative determinations of the amounts of radioactive elements present and as a means of stratigraphic correlation.

Portable Geiger counters and scintillation counters have been developed or modified to meet the needs of the reconnaissance geologist in exploration for radioactive materials. Car-mounted radiation-detection equipment has been in use since 1945. With the car-mounted equipment, a reconnaissance survey of 200 mi or more a day can be made.

Air-borne radioactivity surveys are also a part of this exploration program. Scintillation detection equipment, developed in cooperation with the Oak Ridge National Laboratory, has been installed in the Survey plane. Higher-than-normal radioactivity detected by these instruments as the plane flies about 500 ft above the ground may indicate new sources of radioactive material. At quarter-mile spacing, 100 mi^2 can be surveyed in a day. Air-borne radioactivity surveys have been made in parts of Arizona, Colorado, and Utah as well as in other parts of the United States.

In addition to these studies, the Survey is re-

(Left) The basic design of the gamma-ray logging instrument, familiarly called Barnaby, was worked out by the Union Mines Development Corporation and the Metallurgical Laboratory of the University of Chicago. The instrument has been redesigned and modified by the Geological Survey. More than a million feet of drill holes have been logged on the Colorado Plateau. (Right) Survey geologist testing high-grade ore near a mine portal on the west side of the San Rafael Swell, Utah, with a Geiger counter. Scintillation counters, developed by the Survey, are also used and are in commercial production.

(Left) A photogeologist interprets geologic features from the aerial photographs. He is studying the photographs stereoscopically, using an interpretation stereoscope. Geology is delineated directly on the photograph. (Right) Information interpreted from the aerial photographs is compiled into a geologic map by using many different methods and instruments, such as this radial planimetric plotter.

The Geologic Names Committee reviews all geologic names used in Survey reports to assure uniform and correct usage and advises on the adoption of new names.

(Right) Photogeologic map of an area in the Plateaus.

(Left) Car-borne scintillation detector used for rapid reconnaissance surveys for radioactive minerals. (Right) Setting up a marker for test flights over simulated ore deposits to calibrate the detection equipment in the plane and to study the absorption of gamma radiation in air.

(Left) Nearly 50 different uranium-vanadium minerals have already been identified in the Colorado Plateau deposits. Nine of these have been discovered by Survey scientists in the past few years. Among them are monstrosite, hummerite, navajoite, and rabbittite. Reports on others are in preparation. (Right) X-ray analysis is used to determine the crystal structure of a mineral and is of value in solving broader problems of the synthesis and the natural formation of minerals.

(Left) Drilling operations in Montrose County, Colorado. Many types of information in addition to the occurrence of ore are developed by drilling. Data on water consumption have been used in studying the transmissibility of sedimentary rocks. (Right) Cores such as these show the nature of the subsurface rocks and have been studied in many other ways. Chemical and physical analyses of core specimens provide information used as guides to exploration and geologic thinking.

(Left) Synthesis of minerals is a powerful tool in the solution of many geochemical problems. Some uranium minerals occur in nature in such fine-grained form that their physical properties, especially their structure, can be studied best, or only, in their synthetic equivalents. (Right) Lead-uranium ratios of Plateau ores, determined by mass-spectrometer studies, indicate the ores are about 70 million years old. These studies have had a considerable effect on the hypotheses concerning the origin of the ores, which had previously been considered to be much older.

sponsible for a considerable amount of drilling. The principal objectives of the drilling program are to find new deposits of carnotite and to appraise the uranium resources of the area. Drilling also supplies additional information on subsurface stratigraphy to the geologist, and enables him to test his hypotheses on the occurrence of the ores.

Fundamental studies of the laws governing the origin and concentration of uranium ores have been undertaken in the laboratory as well as in the field. These include investigations of the mineralogy of the Plateau ores, the behavior of uranium during weathering, the synthesis of uranium-bearing minerals, the relation of the uranium ores to "fossil" water tables, and the isotope geology of uranium and thorium and their decay products.

Topographic mapping is basic to many activities, including geologic mapping, water-resources investigations, and administration of the mineral-leasing laws which are the responsibilities of the

(Left) Electron microscopy is a powerful tool in mineralogic studies. These crystals of metahewettite are about 12 microns long. (Right) As a vital part of all these investigations, more than 200,000 samples have been analyzed for uranium in the Survey laboratories. A variety of methods for the analysis of uranium and thorium in rocks, ores, minerals, and natural waters have been developed by the Survey. Some are exceedingly sensitive, as little as one ten-billionth of a gram of uranium being readily detectable.

Ground operations near Escalante, Utah. Traveling in this country can be exceedingly difficult. Canyons like this, dry or with little water during much of the year, are danger spots in time of cloudburst.

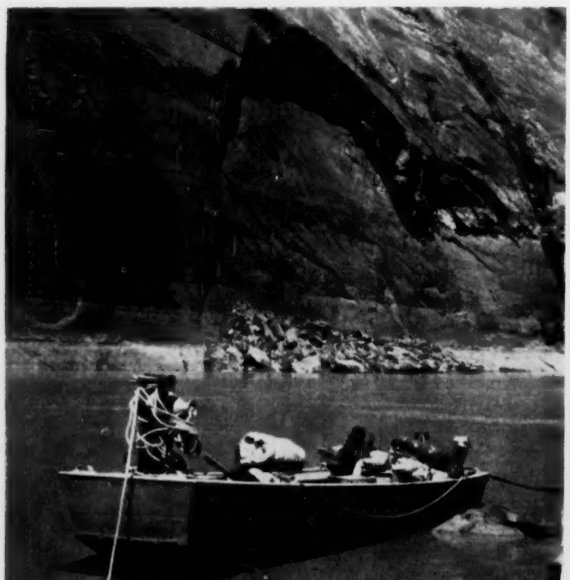
Geological Survey. These maps are also widely used by public and private agencies in their work in planning and construction, not only on the Plateaus, but throughout the country.

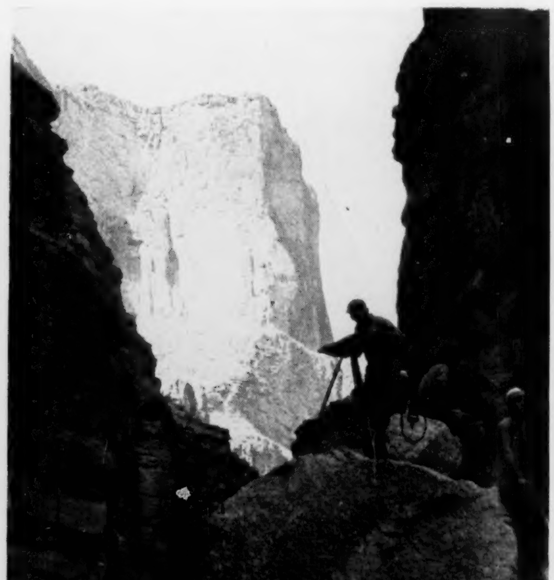
The Colorado Plateau Province is a difficult one to map topographically because of the nature of the terrain. In some of the early Survey reports, it was pointed out that the great size of the plateaus and the flatness of their tops posed difficult problems to the topographer. Yet maps at a scale of 4 mi to 1 in. were prepared for many parts of the area.

Modern mapping is generally at a scale of about 1 mi to 1 in., and in critical and economically important areas, supplementary mapping at a scale of 1 : 24,000 is needed.

Modern-day topographic engineers, working in parties of seven or eight, can triangulate an area of about 3000 mi^2 in one field season by using helicopters and portable radiotelephones in addition to their normal surveying equipment. Use of aerial photographs and photogrammetric techniques, in addition, greatly reduces the amount of field work necessary in some areas.

Although exploration for uranium plays a large





(Left) Motorboat used in river surveys during the twenties. Resting at noon 6 mi above Lees Ferry, Arizona. (Right) Carrying the survey into the canyon of Cataract Creek, about 10 mi below Havasu Creek.

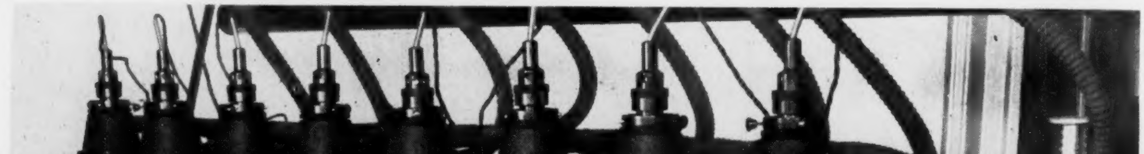
part in the Survey's current activities on the Plateaus, other investigations are under way. Most of these are devoted to water-resources studies, which in this arid country are of great importance.

The Survey has been active in water investigations in the Colorado River Basin since 1879, much of its work in continuation of that initiated by Powell. The first gaging station was established on the Gila River at Buttes, Arizona, in 1889. Special surveys showing the plan and profile of streams and sufficient topography to cover possible locations for structures needed for a comprehensive scheme of water development were begun in the basin in 1909. Records of discharge of the river and its tributaries, needed for water development and utilization, were collected over long periods.

Because of the inaccessibility of the middle stretches of the Colorado (from the mouth of the Green River to the Grand Wash, a distance of 500 mi, the river could be reached at only three points with a wheeled vehicle) nearly 40 years passed after the establishment of the Survey before the river work was carried into the middle section of the basin. When conditions arose creating the demand for scientific data in connection with comprehensive plans for utilization of the river waters for power and irrigation, however, gaging stations were established at Lees Ferry, Arizona, in 1921 and at the mouth of Bright Angel Creek in 1923. Surveying of the stream profile from Green River, Wyoming, on the Green River, and from Grand Junction, Colorado, on the Colorado River to the Mexican boundary, a distance of 1500 mi, was completed in 1923. Much of this special survey work was done by land parties, but boats were used in several stretches of the river.

Helicopters operate a shuttle service from a base camp or from roads, landing the men and their instruments on otherwise inaccessible peaks, and moving them from peak to peak as required. This helicopter is about to land on the Toadstools, a small flat-topped mesa standing more than 1000 ft above the river near the junction of the Green and Colorado rivers in southeastern Utah.

Each triangulation observing party carries a portable radiotelephone with which to communicate with the base camp, the helicopter, or with other observers. The project engineer here on Castle Butte has set up his theodolite and plane table to make observations.



Photogrammetry speeds map production. By the use of aerial photographs and stereoscopic equipment, many mapping operations have become office procedures performed by skilled technicians.

Lees Ferry gaging station. This station was established in 1921 and was the first gaging station in the middle part of the Colorado.

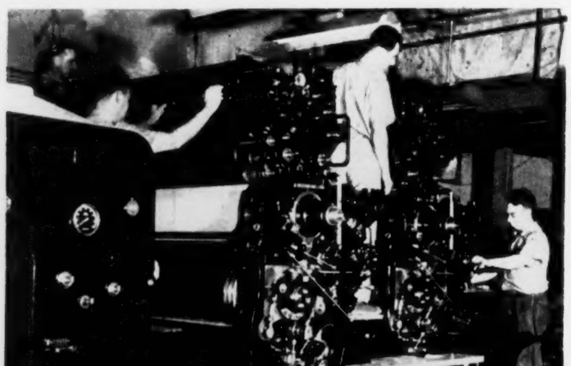
Measuring the flow of water in Havasu Creek. The discharge at this point was 74.5 ft^3/sec.

A silt deposit on the left bank of the river about 2 mi above Lees Ferry.

Topographic and geologic maps are carefully drafted, and a variety of illustrations are prepared for Survey reports.

Copperplate engraving in the preparation of maps has been largely replaced by photolithography, but the art is still preserved for special maps and revisions.

Typing and preparing copy for the printer is an important part of the process of getting the facts to the public.



Off the giant press, Survey maps can be produced at the rate of many hundreds of copies an hour.

At the present time, the Survey is carrying on an extensive program aimed at determining the quantity, quality, and availability of surface and ground waters and providing data for their efficient utilization and conservation. Activities necessary to carry out this program include not only studies of the flow of streams and determinations of the quantity and character of water but also, as the occurrence of ground water is related to geologic structure and stratigraphy, an extensive program of geologic mapping as well.

The data developed in these various investigations are made available to the public in the form of maps and reports published by the Geological Survey and as technical papers in scientific and engineering journals, after they have been carefully reviewed and verified to insure the quality and accuracy of the product.

In this brief review, only the highlights of the Survey's activities in the Colorado Plateaus could be touched upon. With Gilbert, we may say that "the progress of geological exploration has compassed so small a fraction of the earth's surface that the aspect of the science is modified, in greater or less degree, by the addition of each important mass of facts," and that "when the contributions from the Plateaus shall have been made . . . its record will find a place in the history of geological progress."

People, Energy, and Food*

WARREN WEAVER

Dr. Weaver is director of The Rockefeller Foundation's Division of Natural Sciences and Agriculture and is president for 1954 of the American Association for the Advancement of Science. During the last few years Dr. Weaver, together with Dr. J. G. Harrar, Deputy Director for Agriculture, has been traveling extensively throughout Latin America, in the Near East and India, and in Eastern and Southeastern Asia, studying opportunities for expansion of The Rockefeller Foundation's activities in agriculture.

IN this audience I see a formidable number of individuals who are highly competent experts on one or another phase of my topic. I, on the other hand, am only an interested amateur. But, nevertheless, I am determined to proceed, for the things I am going to talk about are of such great and such general importance that, as someone has remarked about war, we cannot risk leaving the matter wholly to the experts. All of us must be concerned.

Although this is going to be a very informal paper, it has a basic plan that is as classically formal as though I were still the mathematics professor I was some 25 years ago. We are going to be talking about a problem—or, more accurately, an interlinked set of problems. First, I shall state what are the principal variables of this problem. Second, I shall give brief descriptive statements about each variable. Third, I shall make some comments about general solutions of this problem. And finally, I shall have a few words to say about one particular attempt to contribute toward the general solution.

The title has already revealed the main variables. They are people, energy, and food. More precisely, we are here concerned, as to people, only with the number of them—with how many mouths there are to feed. As to energy, we will want to ask how much men require; and we will be equally concerned to ask how much is available and from what sources. As to food, we will be chiefly concerned with its energy equivalent. The problem is simply how can we get more food-energy for more people.

First, then, people: how many of them are there? How is this number increasing? The facts of demography are so complicated that we will have to simplify a great deal if we are not to be overwhelmed with detail.

At the time of the birth of Christ, there presumably were from 250 to 350 million persons on this planet (*1*). Some 700 years later, there was about the same number—say 300 million—a long slow decline in total population having been followed by a compensating increase.

It took roughly 950 more years, namely, until 1650, for this 300 million to double to 600 million. But then it took only 200 years, from 1650 to 1850, for the next doubling up to 1200 million, or 1.2 billion. From 1850 to 1950, in only 100 years, the earth's population doubled again, to about 2.4 billion.

Just think of these surprising and, in a way, frightening figures. Since the birth of Christ, the population of our planet has, speaking in approximate terms, doubled three successive times. It took 1750 years in all for the first doubling, but only 200 years for the next, and only 100 years for the most recent. Population not only increases; it grows like a snowball, faster and faster.

Let us view this same sobering growth in another way. During the year 1952, it was estimated that the population of the earth increased by about 60,000 persons every single day, this meaning, of course, a net increase, the births exceeding the deaths by that figure. During 1953, this figure had increased to about 70,000 a day.

I assume that you had breakfast this morning about 7:30 and that you will dine this evening about 12 hours after breakfast. As you sit down to the table tonight, stop for a moment. Ask your wife and children to crowd over and make room, for there will be about 35,000 more persons at the world's dinner table tonight than were there this morning for breakfast.

There are all sorts of partial explanations of

* Originally presented informally as one of the afternoon lectures in the series arranged by the National Academy of Sciences and the National Research Council (in Washington, on January 26, 1954). This paper was thereafter written out, at the suggestion of the Editor of *The Scientific Monthly*, in essentially the form in which it was orally given.

these facts. One major influence has doubtless been the advance in medical science and the improved practice in public health that have combined to bring so much of disease under control and have so notably lowered infant mortality and increased life-expectancies. But there surely are many other factors as well.

We have vastly more and better statistical information about population growth than we used to have, but we cannot claim to have gained any very satisfying understanding of the real meanings behind all the numbers.

Some more optimistic persons, for example, appear to be convinced of the reality of the causal relationships in a chain of events like this: improvement in health—more scientific agriculture—rise in general production—increase in education—higher standard of living—voluntary and automatic decrease in birth rate—a stable population and a better life for all. But other persons wonder whether the causally related chain is not, at least in some places and times: improvement in health—more scientific agriculture—rise in production—increase in population—the rich get richer—just enough more education to produce discontent—social chaos—starvation and misery.

So much, at least at the moment, for numbers of people. How about energy? How much, first of all, do we need per person per day?

In the United States, each individual person uses, each day, about 3000 calories as food (*2*). Each United States inhabitant averages more than 40 times as much, or about 125,000 calories per day, for heat and power. It is, at first hearing at least, surprising that in our own country about 25 percent of our total energy bill is devoted to space heating—to keeping our buildings warm—whereas only one-tenth of that amount, or about 2.5 percent of the total energy bill, is used for food.

For the planet as a whole, the figures—necessarily rough—appear to be that every individual person on earth uses up, on the average, about 2400 calories per day for food and about 6000 calories per day for heat and power. Anyone who is intrigued with oversimplifications might very well look at these figures—3000 and 125,000 for the United States, and 2400 and 6000 for the earth as a whole—and ask himself if he knows of any more compact explanation than is found in these contrasting numbers of the fact that the United States is variously respected, feared, admired, envied, and disliked by the other peoples of this earth.

If we take the planetary averages and multiply them by the earth's population, it turns out that the total need for energy, by all the earth, is about 15 million million calories per day, about one-third of this being for food and about two-thirds for heat and power. This number is so large that it is a little uncomfortable even to repeat it several times; and suppose we, therefore, agree to use the name "one global unit of energy" for a million million calories. Then the global needs per day are 15 global units.

To meet such demands, what daily supplies of energy are available?

From the simplifying point of view of present-day knowledge, there are only three known sources of energy, and at least two of these differ only in the location, rather than the kind, of the source. Thus, as the first large category, we have energy arising through nuclear disintegration cycles in the sun—what we usually simply call solar energy. Second, we have energy released from nuclear disintegration cycles here on earth—what we have recently come to call atomic energy. And finally, we have a small amount of energy from cosmic sources. The energy of rotation of the earth is the only terrestrially available item I know of in this last category, the energy of the tides being derived from slowing down the earth's rotation. This is a relatively small and very inconvenient source, and I will not refer to it again.

From the sun, we have the currently given solar energy, which daily bathes this planet. We have solar energy, received a few weeks or months ago, that has been temporarily stored in the current crop of green plants, or temporarily stored in water which has been raised by the sun and whose elevated position now makes it available to produce power, or temporarily stored in warmed-up tropical waters, or temporarily stored in winds and atmospheric electricity. Then we have solar energy, received many hundreds of thousands of years ago, that is stored underground in our fossil fuels. These three types of energy, all derived from the sun, differ in many important respects. For present purposes, it is important for you to note that the current daily supply and the temporarily stored supply are like income, in that they are renewable supplies. The sun gives us a daily allowance payable each morning. Since we collect almost none of that daily allowance, the sun, like a tolerant parent, saves up some of the energy we do not collect currently and lets us draw on that store some days or months later. Both the daily account and the weekly-monthly account are kept refilled by the generous sun.

But the permanently stored supply—oil and coal from prehistoric green plants—is capital wealth that the sun has bequeathed to us. What we use up of that supply is gone for good (or perhaps we

ought to say, for bad). And the bank in which this capital is stored pays no interest on deposit accounts.

In this talk I am primarily concerned with the problem of currently balancing the books of mankind, using only the renewable or income kind of energy. Thus I will have nothing further to say about the capital supply of fossil fuel. And, for the same and other reasons, I will also have nothing further to say about atomic energy. This latter topic does not lend itself well to a discussion of this sort. One either knows so little about it (which is my case) that he cannot say anything useful; or he knows so much about it that he must not say anything useful.

Restricting ourselves, then, to the renewable aspects of solar energy, what is available? Every day the sun bathes our home planet with radiant energy to the amount of about 1.4 million of the previously defined global units (that is to say, about 1.4 million million million calories). Some of this is temporarily stored as available water power, there being about 200 global units per day available from this source. Some is temporarily stored in the current crop of green plants, there being about 33 global units per day available from this source. Some of it is temporarily stored in the heat of tropical waters, there being about 10 global units per day available from this source. There are also about 5 and 1 global units, respectively, temporarily stored in atmospheric electricity and in wind.

Any person, it seems to me, has two main reactions to these figures: (i) the available supply of solar energy is almost incredibly large, and (ii) the effectiveness with which we use this available energy is almost incredibly small.

The daily supply of energy from the sun—1.4 million global units—is, we see, nearly 100,000 times the total present demand of our earth for about 15 global units a day. Many illustrative examples have been invented to try to give some realistic understanding of this vast amount of energy we receive from the sun. For example, taking into account atmospheric absorption, percentage of clouds, night, and so forth, solar energy falling per day on a square only 31 inches on a side is equivalent to the 3000 calories that a person needs as food. Put in spectacular (but wholly unrealistic) terms, at perfect efficiencies a man needs only about three-quarters of a square yard as a personal garden to satisfy completely all his need for food.

Putnam has given another striking example. An atomic bomb achieves total destruction over a certain area, using a certain amount of energy in so doing. This amount of energy is equal to the solar energy falling on this same area in what length of time? The answer is, just about 1 day.

If there is so much available, and if we scramble so hard to make use of so little of it, then clearly the efficiency of our procedures must be low. We sneer, nowadays, at the low efficiency of an old-fashioned low-temperature, low-pressure steam engine. It might be only 5 to 10 percent! But the over-all efficiency of a cornfield is something of the order of two-tenths of 1 percent. And if we insist on feeding the corn to a steer and eating beefsteak, then the over-all efficiency is further reduced by a factor of about 10.

The upper limit to the efficiency of the photosynthetic process itself is believed by many to be about 20 percent, although this figure is still in doubt, some experts being convinced that the correct value is substantially higher. From the point of view of the present discussion, perhaps the most striking fact is that, even yet, our knowledge of this absolutely vital phenomenon is so insecure that there can be such differences of opinion.

It is very easy to be too enthusiastic about the available supply of solar energy, for it has two very serious drawbacks, one geometric and the other thermodynamic. The geometric trouble is that solar energy is all spread out. It is a little like having pennies dotted sparsely around, one every 100 feet. On a big area, this would be a lot of money. But to walk around picking them up would cost, in time and energy, just about as much as the pennies are worth. In somewhat the same way, the capital and upkeep costs of large-area installations to capture the sun's energy turn out to be so great that they make the procedure questionable, at least as we have so far been able to think of possibilities.

The thermodynamic trouble is closely related to the geometric one. A heat engine is not efficient unless it operates at a high temperature. When the sun rather gently warms up a large area, there is a lot of energy involved, but it is thermodynamically poor energy because of the low temperature. To get high temperatures, and resulting high efficiency, one has to concentrate—to focus. And here one is right back with the geometric difficulty and with the practical difficulty of the capital and maintenance costs of large-scale devices for accepting a lot of spread-out energy and focusing it onto a small area.

Turning now to the third variable, food, I need only point out that, from our present point of view, food and energy are pretty much the same thing. They are, of course, not exactly the same thing. I am not forgetting the importance of a proper dietary regime. I am not forgetting the need for vita-

mins, trace elements, and so forth. Indeed, I am not forgetting such useful and pleasant things as texture and flavor; and I would, in passing, express the pious hope that the day never arrives when I cannot distinguish between a kilowatt and a T-bone.

The fact remains, however, that food, looked at from a coldly analytic point of view, essentially requires only three ingredients: a sufficient supply of relatively few kinds of atoms, chiefly carbon, nitrogen, oxygen, and hydrogen; a supply of the energy necessary to build these atoms into molecules possessing the sorts of energy-rich bonds with which our metabolic system can deal; and the ingenuity to take the atoms and the energy and produce the molecules. The situation here is a little like that of a child at the destructive stage, who gets his parent to use energy and ingenuity to build the blocks into a structure and then gets his own chief satisfaction out of the process of tumbling the house down.

Fortunately we do not need to worry about the basic supply of necessary atoms. Except for a wholly negligible amount of transformation, these atoms are indestructible and can be used over and over again, just as the child's blocks can.

What, now, is the general problem in which these three variables are involved? There is, in obvious fact, a whole array of troublesome problems. Even if enough ingenuity and energy were available to produce enough food for the growing numbers of people, there would still be the baffling difficulties of storage, transport, and price, with all the attendant cultural, social, economic, and political complications. And what do men do when they face all these facts and these difficulties?

Many relatively ignorant millions, by remaining mute, in effect say "I haven't the slightest idea what you have been talking about; but I know that I am hungry." Many millions who are not ignorant say in effect, one fears, "These are confusing, difficult, and depressing facts, and I would rather not think about them."

A few persons, hard-headed and useful pessimists, look at a linearly rising line (which they estimate is the best we can hope to do by way of increasing food), and look at a more and more steeply rising curve (which is the way population has been increasing to date), and conclude that we are going to hell in a hand-basket.

A few persons, imaginative and useful optimists, consider the fact that the sun daily pours on us some 100,000 times as much energy as we need, remember the unpredictable nature of man's ingenuity, and insist that all is going to be well.

A few persons take none of these positions. These latter persons admit that there is a pressing short-range urgency and that there also is a grave long-range problem. They admit the staggering complications and difficulties. They admit all the corrective qualifications and reservations that must be attached to oversimplifications. They recognize that man is astoundingly ingenious, and that he and the vagaries of nature, working together, have confounded just about every long-range prediction ever made. These latter persons refuse to admit defeat; they are determined to help win through to a solution.

This latter list, though small in planetary terms, includes a lot of individual scientists, research groups, industries, government agencies, and international agencies. These men and agencies say, by their total action, that there is one clear opportunity for substantial and fairly prompt relief, this involving the increased adoption by our planet of the methods of scientific agriculture, including of course the reclamation and conservation of productive land. At the least, this move would afford temporary relief and would buy us some time, within which we might hope to make more lasting improvements. And it is worth noting that no one as yet has a demonstrable right, so far as I am aware, to estimate just how temporary or how long-lasting this relief would actually prove to be. In particular, it is impressive that yields of crop plants vary over exceedingly wide ranges, and we do not really know what the upper limit is.

This latter constructive group further says—unless I mistake their voice—that there is a longer range aspect with respect to which mankind has got to make some constructive progress, and this is population control. Admittedly this gets mixed up with all sorts of deep-seated beliefs and practices, and admittedly this is going to be a slow and stubborn business, with all sorts of temporary setbacks. But equally obviously we should and must move in this direction.

This constructive group is also concerned with a host of other interrelated problems, one good example being the village improvement schemes in India, with their combined emphasis on health, agriculture, literacy, home improvement, cooperatives, cottage industries, and other useful aspects of village life. And there are further possibilities, based on a considerably longer time scale, for influencing the food problem on this planet. Of these I will speak in a moment.

I want next to give a very brief indication of the attempt that one private organization—the one that I have the honor to serve—is making to contribute in a modest but concrete way toward the solution of this problem.

A Rockefeller agency (the International Educa-

tion Board) which was ultimately merged with The Rockefeller Foundation gave slightly more than 4 million dollars' aid to agriculture in Europe during the 1920's. However, the more recent and larger interest of The Rockefeller Foundation in agriculture dates from 1941. The first experiment was a collaboration with the Mexican government which was initially limited rather strictly to work on improving the yields of the principal food crops of the Mexican people—corn, beans, and wheat. This has by now been expanded into a considerably broader program, involving sorghums, potatoes, vegetables, forage grasses, and green manures; and there are sections devoted to plant breeding and genetics, plant pathology, plant physiology, entomology, and soils science. Working from a central experiment station, near Mexico City, which is equipped with modern laboratories, greenhouses, and machinery, the program now involves the use of other stations in strategic areas as well as many demonstration plots arranged with cooperating farmers.

At the present time, this program involves a North American staff of 15 members and a substantially larger group of Mexican agricultural scientists. To date, about 220 young Mexicans have received intensive training in this program, nearly 50 of them having been sent to the United States for further academic work. Nearly 50 young agriculturists from Central and South America have also been trained in this program, this being only one of several ways in which this activity has extended its influence throughout Latin America.

The improved varieties of corn developed in this program have by now been planted on nearly one-quarter of the corn land of Mexico, with average increases in yields from 25 to 30 percent. The improved wheats have been planted on more than three-quarters of the wheat lands, with average yield increases of 30 to 50 percent (*3*).

About 4 years ago a somewhat similar agricultural program was set up in collaboration with the government of Colombia. Profiting by the experience and materials developed in Mexico, this activity has developed rapidly. The Rockefeller Foundation has made two agricultural grants in India and, at the present time, is arranging a very limited cooperation with that country in connection with their own work on hybrid corn. Plans are also under consideration for some possible expansion of agricultural interests, necessarily on a most limited basis, in certain selected areas of the Far East.

A general exposition of the principles that have guided this work will be found in the paper by Dr. Harrar, reference to which was made in a preceding paragraph. But in all brevity, it can be said that The Rockefeller Foundation has tried to place emphasis upon the necessity of personnel of the highest personal and scientific qualification, upon stability of planning and support, upon flexibility relative to administrative matters, upon a relatively long-range and basic attack that does not attempt to promise quick results, and, perhaps most of all, upon the necessity to help train the local scientists up to the point where they themselves can carry on.

This operating work in agriculture, which seeks to deal directly with the practical and pressing business of increasing food production, constitutes the contribution The Rockefeller Foundation is trying to make on a fairly short-range time scale. On an intermediate time scale, we are making grants to other agencies to enable them to undertake studies that will contribute to agricultural progress. Our very limited resources necessarily limit us to a rigorous choice of projects of quite outstanding promise and quality. Some of these, such as broad programs at Cornell and Minnesota which seek to increase knowledge of the factors that limit crop yields, or studies at Illinois and California concerning the appearance of strains of insects resistant to insecticides, might with good luck hit pay dirt within a relatively few years. Others, such as more basic studies in genetics, in plant biochemistry, and in plant physiology, are simply aimed at increasing our stock of basic knowledge in these areas, with the confidence that this increased understanding will eventuate, even though unpredictably in detail, in practical agricultural improvements.

On the basis of a still longer time scale, however, The Rockefeller Foundation has an interest in certain lines of research which hold out some reasonable promise of affecting in quite other ways man's eventual food supply on this planet. It is important to speak of these fields of "nonconventional agriculture" with care and reserve, so that one does not sound like the less responsible portions of a pulp magazine. In fact, our own interest in all four of the fields I will mention is not at the level of spectacular gadgeteering but rather at the level of basic long-range research of the sort that may possibly lead, several or many years hence, to more profitable gadgeteering by someone else.

You will remember that earlier I spoke of the fact that food primarily depends upon atoms, of which we have plenty; on energy, of which there is plenty available; and on ingenuity. The areas of activity that I am about to suggest are, I think, illustrative of the role that human ingenuity must play in this problem.

The first of these fields which may affect man's future food supply is research concerning solar energy, including photosynthesis as well as studies of

other types of transducers whereby the electromagnetic energy from the sun might be converted, with useful efficiency, over into some chemical or electrical-stored form. This is, of course, the field most immediately suggested by this paper.

Second is the whole subject of marine resources, especially the energetics of the life-cycles in the sea. The total amount of carbon fixed through photosynthesis on land is of the order of 20,000 million tons annually. But more than seven-tenths of our planet is covered with water; and the total amount of carbon fixed through photosynthesis in the oceans is at least as large—and may even be 10 times as large—as the amount fixed by land plants. Yet of the total food of this planet, only something like 1.25 percent comes out of the sea. These figures clearly call for more energetic exploitation of marine resources. We do not think, at The Rockefeller Foundation, that it is our job to be concerned with such things as testing new electric devices to attract fish. We do recognize a long-range interest in learning more about the basic aspects of marine biology.

Third is the subject of water. Perhaps the most common limitation to crop yields is the lack of water. It is not a problem of more total water for the planet but rather a problem of seeking a more favorable distribution, with water at the right place at the right time. One phase of this problem is the question of methods that are economically feasible for the purification of brackish or salt waters. Another is the long-range possibility of learning enough about cloud physics and chemistry, so that man may some day favorably influence the distribution of rainfall. Still another is the possibility of learning more about the utilization of water by plants, so that one might be able to develop specialized varieties which could produce more useful crop yields under semiarid conditions.

Fourth is the general field of microbiology. I am not thinking here solely of such things as raising Chlorella for proteins or fats, although such procedures may well have value in certain parts of the earth. I am thinking more generally of the fact that microorganisms, as the geneticists have been teaching us, are highly skillful and specialized little chemists, carrying out organic syntheses at moderate temperatures and with an expertness and efficiency that the chemistry professors can admire but not duplicate. These industrious little creatures seem entirely happy in their work, they demand for wages only the starting materials, and, as far as I know, they have no union requirements concerning vacations, pensions, or health insurance. Man has as yet made only limited use of them. What and how large the possibilities are, I surely am not the one to guess. But I am entirely confident that this is a general area within which man needs, and can some way profit by, more knowledge.

We recognize that man does not live by bread alone; but we think it is hard to stay alive without it. We do not suppose that men are automatically made good by filling their stomachs; but we believe that it is not realistic to expect a man to behave rationally or decently if he and his family are hungry. In other words, we believe that in working for more food for more people, one is working toward a better world.

References and Notes

1. I am making use, here, of Palmer Putnam's fine new book, *Energy in the Future* (Van Nostrand, New York, 1953).
2. Throughout this paper, a *calory* always means a *large calory* or *kilocalory*. It is roughly equal to the energy released in the burning of an old-fashioned wooden or "kitchen" match. There are about 10 calories of food energy in a single ripe olive, and from 300 to 500 in a candy bar.
3. For a more detailed description of the agriculture work of The Rockefeller Foundation, see "A Pattern for International Cooperation in Agriculture" by J. G. Harrar, Deputy Director for Agriculture in The Rockefeller Foundation, *Advances in Agronomy*.

U. S. Geological Survey Plane

The U.S. Geological Survey plane, shown on the front cover, is flying over the Painted Desert, southwest of Cameron, Arizona, while engaged in making an aeromagnetic survey of the Colorado Plateaus. Note the detector or "bird" in the lower part of the photograph. The edge of Coconino Plateau is in the background.

Human Relations and Technical Assistance in Public Health

E. ROSS JENNEY and OZZIE G. SIMMONS

Dr. Jenney's earlier career in medical missions included an assignment in Labrador with Sir Wilfred Grenfell. In 1945, he served as chief of public health, Allied Mission to Norway and, at the same time, made two voyages to Murmansk, being in charge of repatriation of the very sick among Russian prisoners in Arctic Norway. Subsequently, he was chief of public health, Military Government of Bavaria. After entering the U.S. Public Health Service, he served as chief of the public-health division of the Technical Cooperation Administration in Indonesia and at present is Chief of Party in Chile for the Institute of Inter-American Affairs (FOA). Dr. Simmons' earlier work included several years of field research among the Spanish-speaking people of the American Southwest. From 1949 to 1952, he was field director in Peru of the Smithsonian Institution's Institute of Social Anthropology, engaged in teaching at the National University in Lima and in field investigations in contemporary Mestizo cultures. In 1953, he served as staff anthropologist for the Institute of Inter-American Affairs in Chile. At present, he is Research Associate in the School of Public Health, Harvard University, and is director of Harvard's research on the community aspects of psychiatric rehabilitation.

THE United States, the United Nations, and many private organizations, through their technical assistance programs, have become formally committed to the exportation of skills and techniques to the so-called "underdeveloped areas" of the world. This commitment represents an explicit recognition of certain differences between the "more developed" societies and those of the "underdeveloped areas" in scientific and technological advance, and a corresponding impulse to share this knowledge with other nations that may benefit by it in coping with the problems involved in improving their standard of living.

This impulse to narrow the gap between a more advanced technological level and that of the underdeveloped areas is praiseworthy but often carries with it the assumption that a people are underdeveloped or backward, not just in technological achievement, but in all aspects of their culture. It is, perhaps, possible to evaluate relatively the science and technology possessed by a particular people, but it is untenable to maintain that one culture is more "advanced" or "better" than another with regard to such qualitative aspects as values, ethics, esthetics, and so on. The assumption that a people as a whole are backward makes for a patronizing attitude toward them that is hardly conducive to the international cooperation based upon mutual respect that technical assistance programs have formally adopted as part of their policy. Moreover, if a people as a whole are considered backward, we are likely to attempt to diffuse not only our technical skills but the cultural context in which they were developed in our society, one that is not necessarily in accord with the culture of the people we wish to help.

This article will undertake to point out some of the factors that might profitably be taken into account in the orientation and preparation of the personnel selected for technical assistance programs in public health abroad. An effort has been made to spare the reader a repetition of those maxims with which a public-health worker, by virtue of qualifying for his assignment, can be assumed to be familiar. To receive a directive stating that "team leaders should be selected carefully" is little more

than an annoyance to a technician who stands knee-deep in foreign bureaucracy. We do not tell a sailor to keep his ship off the rocks; we give him the location of the rocks. In general, the admonition needed by an American in a foreign field does not call for a restatement of the concepts with which he grew up, which he will not forget and which, indeed, are what made him an American.

Establishing Relations with Collaborating Officials

More than mutual good will is usually necessary for the formation of effective relationships between technical-aid personnel and local (*1*) collaborating officials. The local collaborators are ordinarily high-level officials who hold the rank of cabinet minister or secretary general. Their concepts of proper protocol and etiquette will differ radically from the orientations to "shirt-sleeve diplomacy" that govern the American technical specialist's approach to the situation. The local official may resent the easy, informal ways of the American as manifesting lack of proper respect for the status he holds and for his country in general, while the American may regard the local official's insistence on decorum and etiquette ritual as pretentious and "undemocratic." There is often great sensitivity about real or imagined condescension on the part of the American and a consequent need for the latter to bend over backward to avoid giving this impression.

Most specialists sent abroad will undergo the experience of being forced into a situation of high-level diplomacy to which they are likely to be unsympathetic by virtue of their cultural conditioning, and for which they are not prepared by their technical training. It is not proposed that diplomats be substituted for public-health and agricultural specialists, but that the latter receive some preparation in how to be diplomats. The sheer exercise of technical competence is not enough, since the specialist must also be able to establish and maintain successful relations with his local collaborators if he is to create an environment in which his technical contribution will be accepted.

The nature and extent of the technical contribution the American specialist can make is also dependent upon the quality of his adjustment to the working of the local bureaucracy. Unless he has held a Government position prior to his foreign appointment, the specialist has usually had little experience with bureaucracy in his own country, but he will feel its impact at practically every step in carrying out the objectives of his mission abroad. Subjected to a full dose of bureaucracy for the first time in a foreign country, the specialist is likely to conclude that bureaucratic bungling and delay are typical only of the local country. The public-health specialist, for example, in his work at home, may have found medical supply to be no more than a matter of receiving and inventorying goods and materials, but abroad he will find himself involved in questions of strategic material priorities (bureaucratically defined as such), dealings with customs officials, and problems of shipping priorities, harbor, warehouse, and transportation facilities, and various sorts of clearances—all of which involve endless reams of paper work. Orientation courses for technical personnel to be sent abroad would do well to create some awareness of the bureaucratic impedimenta likely to be encountered in operating a technical-aid program and to stress the fact that such encumbrances plague government programs everywhere. Awareness of this will strengthen the specialist's tolerance in coping with local bureaucratic frustrations and minimize indulgence in the fault-finding that is hardly conducive to good relations with local collaborators.

A word of caution may be inserted regarding the type of incumbent to be found in the high-level government positions with whom the American technician will be called upon to collaborate. He is likely to be of upper-class status and a cosmopolite educated in Europe or the United States. As such, he will hardly be representative of the mass culture that a technical-aid program must of necessity take into account, so that his generalizations and evaluations of his people and country are likely to be highly colored by his class point of view and are to be taken with more than a grain of salt. In many Far Eastern and Latin American countries, collaborating officials hold their positions by virtue of membership in a ruling clique. If the clique is pro-American, the specialist's close association with it may both isolate him from the larger community and distort his estimations of the community's receptivity; and, if the clique is anti-American, its members would hardly constitute fit guides for evaluating the realistic situation the specialist will have to work with.

Personal Adjustments to the Local Culture and Social Structure

The new arrival usually suffers a series of inconveniences, some petty, others more serious, in his very first contacts with the local culture that may importantly influence his evaluations of it. Dealings with the local bureaucracy in securing a customs clearance for luggage, driver's license, and residence permit may be a slow and tortuous process. The different patterns of distribution of goods

and services are almost certain to cause confusion; the division of business hours into morning and late afternoon, prevalent in many foreign countries, so that everything is closed down during the "best part" of the day, is highly frustrating to most Americans; and there is the general exasperation born of bucking a system that operates at a relatively slower tempo from that characteristic of the United States.

The problems involved in getting settled in a new place, bothersome enough at home, are considerably magnified and aggravated for the American abroad. He may possess no flexibility with regard to "living off the country" and may manifest an earnest and persistent desire to re-create a stateside environment in foodstuffs, artifacts, and so on. Preoccupation with securing his household shipment, which may be delayed for many months, with finding a dwelling that is neither too pretentious nor too shabby (in most countries the equivalent of the American middle-class home or apartment is not available for renting, and the American must either take upper-class quarters, sometimes at exorbitant rentals, or be content with what he regards as substandard housing), and with finding an appropriate school for the children are all tasks that make substantial inroads into the time available for occupational duties and have a great deal to do with determining evaluations of the host country. Finding the local people "wanting" when one is heavily dependent upon them, as in the early stages of residence when there is a great need for plumbers, carpenters, electricians, tradesmen, and so on, is likely to rankle for a long time.

Not the least of the problems that confront the newcomer is the adjustment to his own countrymen. The American community abroad is a phenomenon created in part by the same factors that lead immigrant groups everywhere to huddle together, because of the common bond of likeness to one another and difference from the native and other ethnic groups that compose the country's population. It provides an effective device for avoiding what seem to be imposing problems of relating oneself to new lifeways that seem strange and enigmatic.

The American's situation, however, differs importantly from that of the average immigrant in that he enters the new culture on at least an equal-status basis with the local population and, more frequently, in a status superior to that of the vast majority of the local population. His isolation is, therefore, more a matter of choice than necessity, although this may be rationalized by claiming that the local people do not open their doors to Americans (not always a rationalization since it is sometimes true).

Although access to a going emigre American community undoubtedly offers the advantage of easing the newcomer's first adjustments to the local culture, it may in the long run not only severely limit his opportunities for enriching himself by life in a culture other than his own but may actually be detrimental to the interests of the technical-assistance program. With regard to the latter point, the American community, by becoming the individual's chief source of information about local lifeways, provides him with a ready-made set of stereotypical beliefs that become his guide to action in dealing with the local population and, by encompassing all his leisure time, prevents him from testing out the validity of the stereotypes through exploration of aspects of the local life.

Keeping oneself free, or relatively free, of the American community is no easy task, since pressure is placed upon the newcomer to join its 100-percent American organizations and to accept his place in the eternal round of mutual entertainment. The deviant, or nonconformist, is usually looked upon with suspicion and may be attacked through gossip, which can be extraordinarily effective in a small community. If the American does establish relationships with members of the local population on a social basis, it is usually with those who are fluent in English and have "American ideas." Thus, intercultural contact, where it does take place, is established only with those who are not typical of their people and who will provide the American with a watered-down version of their culture, because they are sensitive to American prejudices or may themselves partake of the same prejudices.

Owing to the style of living permitted by the dollar advantage and to the position occupied by Americans, there is sometimes need for moderation to keep within bounds the heady delights of access to a higher status than has been ordinarily enjoyed at home. The availability of domestic servants at low cost, the unaccustomed prominence (with its press interviews and fishbowl living), and the access to upper-class country clubs and entertainments are all departures from life at home that must be taken in stride if the American is not to entertain exaggerated notions of his own importance.

Among the positive measures for constructive and fruitful adjustments, perhaps the most important is learning the local language, which not only will increase the effectiveness of the specialist's contribution but will be appreciated by the local population. The attempt to do so is usually interpreted

as a demonstration of respect for the local culture, while lack of interest is construed as just another manifestation of the American's attitude of superiority and is resented accordingly.

In some of the world's areas, there is pervasive use of a secondary language in addition to the primary one. The secondary language may be English, but in Indonesia it is Dutch, in Indo-China French, and Africa is sliced up into areas where one or another of the European languages is the secondary one. In such countries as Burma, Siam, and India, the foreigner is not expected to become fluent in the primary language; but even in these countries, where English is the secondary language, it will be resented if no attempt is made to acquire at least a rudimentary knowledge of the courtesy and other common phrases. In Latin America, on the other hand, a nodding acquaintance with the local language is by no means considered sufficient, so that a constant effort to acquire fluency is really obligatory. In some places, the secondary language is likely to be used as the primary by the educated local officials, as in Indonesia, where they speak Dutch. Indonesia represents an extreme case in that it has 18 basic languages and more than 200 local dialects, so that learning the "language" is hardly realistic. In this case, a smattering of primary and secondary languages is all that can be hoped for, but the demonstration of effort to learn will be appreciated even if fluency is out of the question.

Many Americans arrive at their foreign assignments imbued with the determination to learn the local language, but this progressively weakens as they become aware of the degree of effort required, and they end up content with a severely limited vocabulary of the basic words that they consider sufficient to carry them through most of the formal contacts required by their duties. It must be admitted that there is a great discrepancy between an American's first efforts in learning a language when he arrives in a foreign country and his ultimate accomplishment. This discrepancy stands out in bold relief throughout the world, where we share with the British an exceedingly poor reputation in this respect. The pattern contrasts sharply with our own unreasonable expectation that every foreigner should be conversant with English as soon as he arrives in the United States.

It is usually necessary for an American to tone down his characteristic aggressiveness and informality if he is to conform to local etiquette, and he will do well to keep conspicuous consumption in line with local means of reciprocity (for example, not too lavish a display of items that can be obtained by local people only at exorbitant prices). Indication of interest in and appreciation of local cultural development will win much more confidence and respect than will a blatant preoccupation with technical deficiencies, which everyone recognizes and which are the principal justification for the American's presence in the first place. It is the devaluation of all local cultural achievement through prejudgment by letting technical deficiency stand for total deficiency that makes for a patronizing attitude and discourages the acceptance of the local people on a equal-status basis.

Dilemmas in Program Planning

It is natural that the objective of a collective human endeavor should be concrete in its broad concept but vague in its application. The technical assistant reaches a foreign country with certain convictions concerning his part in a commendable international enterprise already expressed in tried-and-true phrases—technical cooperation, good neighbor policy, collective security, mutual assistance, sharing of skills, and so forth. Invested with the rank of "shirt-sleeve diplomat" by the expedient of his travel orders, to him falls the task—loosely referred to as implementation—of actually doing something about a policy that has been so convincingly expressed in the facile terms of international good will.

The public-health specialist has the distinct advantage of having as his objective the improvement of the essentially basic unit of any country's economy—the human being. He has the right to assume that his endeavor will be profitable, that his skills are directed toward providing a commodity for which the market is unquestionable. On the other hand, the engineer must weigh the relative costs of hydroelectric versus coal-generated power or the wisdom of beginning an industry which subsequent market failures may ruin. The vagaries of a changing economy may even upset the best plans of the agriculturist in a way that cannot affect public-health objectives.

Although the public-health worker holds a thesis that is hard to discredit (even if it is ignored), he must face the choice of certain radical alternatives in objectives before he can begin to think of planning. He has the choice of concentration versus diffuseness, of short-range versus long-range, and of conquering a small problem versus beginning a limited attack on a large problem. Among the several alternatives available for selection, two definite types of objectives are likely to emerge. One is the concentrated, short-range all-embracing attack on a small problem—the impact program—and the

other is the diffuse, long-range attack on a large problem—the demonstration combined with technical training.

The appeal of the former is tempting and its completion is immensely satisfying, particularly since we are now armed with insecticides and antibiotics that give us dramatic material for newsworthy reports. Perhaps it is not too dogmatic to say that such a plan should always be included but with the caution that its significance should be reported with candor. It is likely to be a small drop in a large bucket, is usually dissociated from local agencies and programs, and rarely will have the catalytic effect that an American is prone to anticipate. Its value is usually one of political strategy, and it tends to prove only that we have temporarily fitted the environment to our ideas rather than permanently fitted our ideas to the environment.

The demonstration and training objectives provide an opportunity for coordination with parallel economic developments in other fields and for close association with, or implementation through, permanent relevant agencies that can be expected eventually to carry the project forward. Deficiencies in the public-health field are interwoven with economic deficiencies; and, since the solutions are interdependent, coordination with agencies in other fields can provide a much more efficient solution than an enterprise limited to the scope of health. At the same time, the local burdens of housing and transportation that any program imposes on an underdeveloped area can be shared by a coordinated program directed toward an area development total in scope.

We search—sometimes frantically—for some axiom to serve as a guide in the selection of the objectives of a technical-assistance program, and perhaps there is only one: the capacity to absorb is inversely proportional to the need. The least can be done where the need is greatest, and the most can be done where the need is least. Technical assistance, like any other attribute imported from a highly developed culture, can be sand pounded down a rat hole. Where medical care is nil, roads are poor; bad roads mean inadequate bridges, few vehicles, and little knowledge of maintenance; hence, the inappropriateness of a mobile clinic. On the other hand, if we contribute to the area most able to absorb technical skills, we have chosen the spot where we are least needed.

Program planning must be based on a situation analysis composed from truly relevant data. Herein lies the danger of too much surveying, and it is reasonable to suppose that officials in "underdeveloped" countries have been driven to exasperation by the incessant requests for surveys during the postwar years, especially by those that have resolved themselves into reports rather than into action. It was pointed out quite accurately in an editorial in a Far East newspaper that the funds expended in having foreign technicians study a certain need would have remedied the situation to a substantial degree, yet nothing resulted from the survey. Unless the technician is actually exploring the country, a great deal can be accomplished by studying the facts at hand, which often are already compiled in formidable quantities, although in a foreign language. The need deduced from immediate surveys may be interpreted in relation to the American scene rather than estimated in relation to local culture. It is better to begin with notebook closed and eyes open, for the new arrival will search for quite different data later in his career than he will at first. A health worker, if he has not thought the situation over carefully, will be satisfied with data on where hospitals are needed but a year later will be interested in the more realistic factor of the availability of building materials.

Whatever the direction of an objective, its character should be such as to insure eventual operation by existing agencies. A mission's basic purpose is to work itself out of a job, which is the compelling reason for making the endeavor one of cooperation. In policy, we cooperate as evidence of good will and mutual respect, but at the scene we cooperate because we intend to hand over our tools. Cooperation should be constantly looked upon as a teaching mechanism rather than merely as a gesture of international courtesy.

In an underdeveloped area, we select an objective that will give locally meaningful application to an established policy, but we do not accomplish this until we have given countless negative answers to a multitude of proposals. Chief among these are the propositions to provide transportation and equipment which local import restrictions have made prohibitive. In the planning phase, an American technician has difficult adjustments to make; he must divest himself of the notion that planning for human welfare below the elite class is, perforce, accepted as a commendable motive—that is, that social consciousness can be taken for granted—and he must also recover from the shock of finding that his "difficult we do at once" philosophy must be cut down to the size and shape of the local cultural pattern. Furthermore, he must distinguish carefully between underdevelopment actually due to lack of skills and that which is due to a traditional maintenance of underdevelopment as a means of buttressing the position of the elite.

After completing his plans to the finest detail, he may launch his program only to find, to his consternation, that his enthusiasm at solving a problem is not shared by his local colleagues, although they may at the same time provide the utmost cooperation. The problem-solving consciousness of the American is one of his prominent traits and one that he is likely to take for granted in others. In some areas, officialdom may regard the recognition of a problem as sufficient and feel no compulsion to "do something about it." There is more interest in cause than in solution; and, as the problem multiplies, it is met by an accelerated tempo in accusations and expressions of dismay rather than by remedial action. That this condition is found in "underdeveloped" areas should not cause surprise, since it is, in a sense, the definition of "underdevelopment."

However, a gratifying experience awaits the technician when he enters the rural areas and finds that his frustrations diminish as he leaves the level of officialdom. The point of most universal agreement among American technicians serving abroad seems to be this: it is among those who live close to the soil that one finds greater receptivity and a readier appreciation for a better way of doing things. Owing to the heavy weight of tradition, to ignorance, and to suspicion, there are serious obstacles in some areas, but in general a man who can demonstrate a tangible improvement is well received.

Although cultural patterns vary from country to country and sometimes from village to village, experience indicates that there is a remarkable similarity in the attitudes formed in "underdeveloped" areas toward the introduction of American technical skills. There are, one might say, standard recipient reactions. It must be supposed that there are certain constant factors, mainly of a situational nature, that bring this about. Most prominent of these factors is the economic situation common to most "underdeveloped" countries that has created similar dilemmas. Another is the highly developed nationalism, focusing mainly on national pride, that pervades most of the world and makes for ambivalence regarding "foreign" assistance. On the one hand, there is the desire for aid from those who enjoy an advanced level of technological achievement, and on the other feelings of envy, resentment, and jealousy in the face of the "foreign invasion." This circumstance is of more than academic interest; it has the potentiality of providing a certain standard guidance for the introduction of technical skills, applicable to large areas of the world. The recommendations to technical-aid personnel made here are seemingly confusing in that they are cautioned that no two cultures are quite the same; yet they can expect to encounter certain similar responses wherever they go. However, it must be emphasized that the latter are not necessarily caused by cultural factors but by the similarity of social and economic situations associated with underdeveloped areas.

Day by day, we are learning what these responses are, as one country after another forms its inclinations or disinclinations to receive foreign aid; but, although the national reaction is the concern of the top administration, the elements that go to form a national attitude are met head-on by the lone technician. Against some of these, he can be and should be warned, particularly those that directly affect planning. He will find, for instance, that certain elements of the local elite harbor an unabashed assumption that foreign aid will be directed to their personal benefit, and the American may be considered naive when he declines to parcel out his aid in the "right spots." Personal transportation will be quite frankly expected, and there will be requests to equip laboratories, offices, hospitals, and clinics in which the interest is personal. Public health is particularly susceptible to deception in this regard, because the ultimate objective can be construed to be service to the people, although the actual result is to enhance the research or practicing facilities, and hence the prestige, of a single individual. Training grants may take on the flavor of nepotism. Demonstration centers may become showplaces—the "pride and joy" of someone—rather than illustrations of what should be reproduced, in which case they will be deeply resented by the rest of the population, which will recognize them for what they are.

A fairly constant tendency will be the desire for expensive and complicated equipment and an extraordinary disinterest in maintenance. In one instance, five 1935 Reichert microscopes were stored away as "too old-fashioned," and for this reason the students who were to use them were not enrolled, pending the indefinite arrival of later models. When expensive rollers have nothing to roll over because there are no shovels to spread material, when x-ray equipment stands idle for 2 years for the lack of a cable, when trucks are driven to a standstill without oil, the technical specialist learns at what point his planning must begin and appreciates the mutual interdependence of small skills in a program dedicated to innovation; and how much more assured is his success if he creates no more than a slight innovation in old procedures. If he can make no adjustment whatever to the unfamiliar situation,

he may manifest a depressed mental state, which has come to be known as "cultural shock." While this is by no means an American disease, we do seem to be particularly susceptible, perhaps owing to our intense frustration at not being able to "get things done" and our dependence upon certain material commodities. The problem is of sufficient importance to lead recruiting officers to place emphasis on a candidate's previous foreign residence in which he may have proved himself capable of adjustment.

Conclusion

Technical competence will, and undoubtedly should, remain the primary criterion to be utilized in recruitment of personnel for technical-assistance assignments. However, this discussion has attempted to make explicit the consequences that may potentially arise in cross-cultural situations if complete faith is placed in technical competence alone as a means of insuring the success of technical-aid programs abroad. The technical specialist's role is necessarily performed within a context of human relations, and the extent of the contribution he can make depends as much on his ability to adjust to peoples of different cultural backgrounds as on his technical competence.

We may legitimately expect recipient peoples to meet us halfway in facilitating the realization of the joint programs, but in the last analysis the primary initiative lies with us, and we will not secure willing and intelligent collaboration and acceptance unless we are able to present ourselves and our potential contribution in ways that are understandable and appropriate to the people we are working with. Selection of technical-assistance personnel should ideally take into account the personality types that would be most successful in making the sort of adjustments that have been outlined here, but it is possible that the number of technicians available for recruitment is not sufficiently ample to permit much latitude in application of this criterion. More feasible, perhaps, would be the intensive indoctrination and orientation of personnel in the human-relations aspects of the mission they are called upon to perform abroad.

Note

1. The term *local* as employed in this article always refers to the host country and its people, those who are receiving the technical assistance. Although this term is lacking in precision, it seems to be preferable to relatively more precise terms, such as *native* or *indigenous*, owing to the pejorative connotations often attached to the latter by North Americans as well as by other peoples.

Galileo

Please tell the reverend fathers back in Rome
I cannot change the earth or twist the sun.
I swear as holy men swear back at home
That all is finished, all my work is done.
Time will erase the fallacy, the lies.
If it be such, my friend, what use is then
My standing there before the court, my sighs?
Truth is more merciless at times than men.
Here is my hand. It trembles now, my friend,
Not with a frantic fear, but sickened age
That understands the passing and the end
Without a fear that withers into rage.
Here, let me sign these papers if it soothes
The priests—at any rate the earth still moves.

LILLIAN ELKIN

Chicago, Illinois

Science and Social Conservatism*

LEONARD CARMICHAEL

Dr. Carmichael, who is Secretary of the Smithsonian Institution, is the author of the article "Laziness and the Scholarly Life," which appeared in the April issue of THE SCIENTIFIC MONTHLY.

IN *The Education of Henry Adams,* the umbrageous chapter "The Dynamo and the Virgin" has many references to Samuel Pierpont Langley, the third Secretary of the Smithsonian Institution. Adams says: "While he was thus meditating chaos, Langley came by, and showed it to him." This was written when our century was new and when the then recently discovered properties of uranium and radium were first shaking the old familiar science of immutable elements.

This paper is written by one of Langley's successors, the seventh Secretary of the Smithsonian, at a time when the products of uranium are not only better known to science but also are more emotionally considered than they were 50 years ago. Uranium and chaos are not as strange words to use in one sentence as they were in 1900. Adams furthers says: "Langley seemed prepared for anything, even for an indeterminable number of universes interfused—physics stark mad in metaphysics." All this ends in the sad sentence: "Langley could not help him."

In spite of the warning of this failure of one of my predecessors to solve the problems raised by the new science in its effect on human values, some dark imperative seems to urge on the Phi Beta Kappa speaker at this annual meeting of the American Association for the Advancement of Science to look once again at certain aspects of this problem, which has become more, rather than less, sharp as the years have passed.

I shall, therefore, try to consider a few of the areas of impact where science and scholarship forever hammer at the structure of human society. Before Henry Adams' book, much had already been written about the part played by science in the dynamics of social change. But the study of human organizations has another side. In society, as in biology, evolutionary development implies stability as well as change. Conservative structures and functions that have worked well and have been useful in the past are the base on which future new adaptive developments are built, both in organisms and in society.

If the creation of new plants and animals is the greatest wonder of the living world, the second marvel is surely the amazing genetic stability of organic forms. The preservation, unchanged, of some species of organisms during many hundreds of centuries of violently altering earth conditions is a startling fact. The chromosomes of the reproductive cells of animals and plants are unstable, complex, and very specific chemical packets. Somehow, often through literally millions of generations, such chromosomal patterns have maintained themselves with absolute fidelity. While the globe has seen mountains thrust up and worn away, oceans rise and fall, icecaps advance and retreat, certain animal and plant forms have remained constant and unchanged. Those strange living fossils, the coelacanth fishes, have changed little, if at all, since Devonian times, some 300 million years ago. *Limulus,* the familiar horseshoe crab of our eastern beaches, is at least 160 million years old. Of the 50 genera of fossil ants preserved in amber, some may be 60 million years old, and only 20 are now extinct. This conservatism is not of structure only. No biologist can doubt that the habits and, indeed, the social behavior of these fishes, crabs, and ants are essentially the same today as they were millions of years ago when these organisms first appeared with the effective bodily forms that they still maintain.

Anyone who continues to doubt that nature is conservative as well as radical should also study vertebrate embryology. Before birth, every whale

* The 14th Annual Phi Beta Kappa address, delivered at the AAAS meeting, Dec. 30, 1953, Boston, Mass.

has legs, and every human being has gill arches. The vestigial organs of adult men and women, such as the vermiform appendix and the coccyx, sometimes give similar painful testimony.

In spite of this amazing genetic stability and reproduction of form and pattern in sensitive and complex protoplasm, biology has more often been used by social philosophers as exemplifying evolution, mutation, and change than as a pattern for stability and conservatism in society. The same emphasis on change has characterized those who have popularized the study of the inorganic world. Astronomers, physicists, chemists, and geologists, notwithstanding the often startling constancy of the phenomena with which they deal, have not infrequently captured man's imagination by describing the cosmic alterations and movements with which their sciences are concerned. Students of society have been especially fascinated by social change itself. How often we read in a general history such a sentence as: "The next century was one of social stability." And then perhaps pages are devoted to the analysis of dramatic wars and disruptive social upheavals.

As compared with the horseshoe crab, or even the ant, man is, of course, a relative newcomer on the globe. In spite of the recently exposed hoax or what has been well called the skullduggery of the Piltdown man, it still seems highly probable that human beings of some sort have been on this globe for hundreds of thousands of years. For most of this period, however, human habits and social characteristics are known only from paleontological and archeological studies. One cannot be so sure about the social life of a fossil man as of an amber-preserved ant, because man's brain has always made it possible for human organisms to profit both by the successes and failures of previous generations. At best, a written record about 5000 years old is all that we need to consider in detail if we wish to understand human social conservatism or change in an exact way.

The part played by science itself in determining social change has been important only in recent decades. Frederick Albert Lange's notable *History of Materialism* summarized the rise and development, from Thales and Anaximander, of naturalistic and scientific attitudes toward the world and man. Until modern times, however, those who held that the cosmos could be dealt with in exclusively naturalistic terms were a tiny minority. In classic, medieval, and even early modern years such iconoclastic and objective thinkers could only cast little pebbles of thought at the great entrenched citadels of supernaturalism. The fortresses then hardly knew that they were being attacked.

Many of these early naturalistic and scientific thinkers were also anxious to be reformers of society. This was true of Lucretius, as we see in his great didactic poem on man and nature. Francis Bacon's *New Atlantis* is also not an isolated example of Utopian social thinking in a pioneer of modern science. Utopianism is but one of the strands that cultural historians have combed out of the fabric of our modern world. In their analyses, factors such as natural resources, human fertility, political and economic practices, the verbal patterns of philosophic speculation, and science itself can be seen to be closely woven together as determiners of the world that we know.

The French Encyclopedists exemplified the contact between philosophy and life. These reformers placed a strong emphasis on science and the social usefulness of technology. They also taught the denial of stable political authority and challenged the value of orthodox religion for humanity.

The dynamic, strangely influential, vagabond philosopher, Rousseau, also had an exciting role in the verbal part of this still relatively recent intellectual revolution. His warm emotional pages show what has been called "reasoning of the heart which reason itself does not know." He turned his back on the Christian tradition, which holds that each man is responsible for his own moral life and must strive to avoid personal evil and sin if he is to achieve goodness. Instead of this old and tested doctrine, Rousseau made himself believe that man is born good and is corrupted only by a bad society.

This speculation, as popularized by Rousseau, clearly has no scientific basis, but it has been taken over and developed by many later advocates of social change who, strange as it may seem, in other ways like to pride themselves on their complete rationalism and objectivity. During the whole 19th century, this idea found many supporters. Some of the reformers who espoused it believed that, by violent alterations in economics or in types of government and without any hard struggle against evil by human individuals themselves, a golden age could be conjured up on the earth. In William Godwin's ideal society, for example, all mankind was to be made good, and permanently happy, in a single generation by economic reform. Present-day Communists and Socialists have taken not a few of their basic assumptions from this strange fantasy-ladened theory, which has been called the dynamic sociology of meliorism.

It has been said that no intellectual discoveries are more painful than those which expose the pedigree of ideas. Rousseau's romanticism, for example, surely influenced in a real way these dreamy Utopians of the early 19th century. The legislative

programs of social reform of the grave dissenting utilitarian economists, the political stratagems of the Fabian socialists, and even the doctrines and actions of Karl Marx and his later followers all trace back in certain ways to this same muddy spring. The social theory of the modern Soviet police-state with its dictatorial denial of the dignity of man, of human freedom, and even of the importance of truth itself still owes not a little to this old unverified speculation about the basis of human nature. Thus, the early dream of an idyllic, happy, unbridled, lawless state where private property is not allowed to exist and love is free can now be seen to have begotten a strange and ever-terrifying offspring.

Later I shall refer to the need for more fundamental study of the real facts about the inborn nature of man. More complete scientific knowledge in this field will have an important bearing on social and economic theory and on the pattern of social change that our age, or some succeeding age, must finally adopt as it own. Because of its great importance, the relative neglect in our time of the science of human genetics is a puzzle. True, it is a hard area of study, but so also is atomic physics. Both of these fields today have much significance for human destiny. The unchanging facts of human nature can be denied for a time, but eventually, by generations of social trial and error (whether or not helped by scientific understanding), satisfactory patterns of political life must emerge, if man is to live peacefully and creatively on this globe.

The end of the 18th century saw more than hot, cutting words of a bookish debate about social change. The flowing blood of the French Revolution seeped over the intellectual world. All the literate globe knew that Demoiselle Candeille, of the opera, a woman fair to look upon when well rouged, had been set up as the goddess of reason in Paris. As she sat on the high altar of Notre Dame, wine-inspired officials of the new order chanted strange political hymns before her. Is it not possible that today mankind is still punished for this same profane worship of an imitation goddess of worldly rationalism? Service to the true and chaste goddess of real wisdom demands that we try to get behind the slogans and the easy phrases of the quick reformers of our age and look at humanity as it is and not as we wish it were.

The political and economic turmoil of the French Revolution was not chargeable alone to the new science or technology of the age or to a half-intellectual denial of the teachings of orthodox religion. Real and deeply rooted economic injustice made the conflagration possible. Those who see the present-day dangers of revolutionary political systems and the importance of maintaining the highest values of true civilization at its best must ever be the first guardians of social and economic justice.

The French mania, however, once ignited, soon raged out of Paris and fired thinkers throughout the Western World. Its sparks fell where social injustice was not real. Thus, even America was not exempt. Samuel Eliot Morison records in his *History of Harvard College* that, at the end of the 18th century, the spirit of the French Revolution was rampant among the students in Harvard and in other intellectual centers of the country. Morison reports that at this time the typical student in Cambridge was "an atheist in religion, an experimentalist in morals, and a rebel to authority." It is not without interest to note that the Massachusetts legislature took cognizance of these facts and criticized the radical teachings of the books that were then used in this quiet 18th century college. In Philadelphia, one of America's first real mathematicians and astronomers, David Rittenhouse, lost his influence in our new government because of his too-ardent sympathy with the new French radicals.

In the decades since this time—hours they almost seem when we think of our relatives the coelacanth and the horseshoe crab—the pendulum of radicalism and conservatism has oscillated back and forth. Today, at last, as we look at these swinging cycles, new, clear lenses seem to be held to our eyes. Some of us begin to wonder whether ideas and speculations about man's inborn and acquired nature and about society should not be recognized as important and as having a direct effect on our political and economic institutions. The influence of the philosophy of Locke and of Hume, the utilitarianism of Bentham, Comte's positivism, and various theories of collectivism take on a different significance as we now strain our eyes to catch glimpses through iron draperies of the behavior of the political descendants of some of the reforming thinkers who have now set up machine guns about the Kremlin in Moscow.

The intellectual paradox presented by these new developments has not yet been fully recognized by our easy and tolerant society. To take but a single example, in the syllabus in the general introductory course in the humanities at one of our great universities the following sentence appears: "A loyal army and police, a numerous bureaucracy, and a state-supported clergy have been the usual pillars of a conservative order." If instead of the words "state-supported clergy" one substitutes the words "a state-supported propaganda agency," it

suddenly becomes clear that this sentence is not so much a description of any modern, law-abiding, enlightened, and scientifically minded conservative government as it is of the strange offspring of the liberalism and radicalism of the 19th century which we have learned, to our sorrow, to know as fascism and communism.

True democracy, as seen in Athens and early Rome and supremely in the wisdom of the writings of such great Americans as Washington, John Adams, Hamilton, and our other wise founding fathers, is a very different and much more truly conservative doctrine than is any form of modern collectivism, no matter how sugar-coated the latter may be. Russell Kirk, in an admirable recent book *The Conservative Mind,* has again clearly emphasized that Edmund Burke, and many other serious thinkers on both sides of the Atlantic, recognized that our American Revolution was fundamentally different from the later French Revolution. The surrender of Lord Cornwallis found victorious an army of English-speaking patriots who had been defending the ancient conservative freedoms of Englishmen against new and radical usurpations of a designing king and parliament in London.

So far, we have considered the effect of essentially philosophic and political ideas upon changes in man's social order. There can be no doubt, however, that the special methods of science as such, especially in the past 15 decades, have themselves been important factors in promoting social change. Certainly in the second half of this period—that is, since the rise and acceptance of the Darwinian point of view in evolution—a wholly naturalistic and positivistic attitude toward the physical and organic world, including man, has become an intellectual commonplace.

Except for occasional writers who seemed out of step with their times, or clergymen or professional religious philosophers, naturalism, or the reign of law as it has been called, became for a time the generally accepted view of most academic leaders in the Western World. This point of view had not previously characterized all great scientists. Such a giant in logic as Sir Isaac Newton saw no inconsistency between a thoroughly scientific cosmology and great reverence for the dogmas and customs of the orthodox Christian tradition. But this attitude changed rapidly in the second half of the past century. John Tyndall, in his presidential address before the British Association in 1874, delivered what has been called an inquest into the death of the old, supernaturalistic conception of man and society and a funeral oration over its corpse. When this speech was presented, it was reported in the press that it was received with a unanimity of commendation.

At the same time that new scientific ideas were having such great intellectual influence, applied science was also upsetting the old order in other but also profound ways. The industrial revolution and the consequent shift of large populations from rural to urban living rapidly altered many traditional human ways of doing things. The substitution of machines and new energy sources for the age-old labor of straining human muscles brought with it our modern world of factories, easy transportation, and quick world-wide communication. The development of physics, chemistry, and other sciences in large measure made possible this industrial and technological progress. During these same momentous decades, the physical and biological sciences as applied in medicine and in public-health fields began to change world population figures by reducing infant mortality and extending life-expectancy.

This great scientific and technological development and the human and social movements that came with it were, in general, advantageous to man and to society. Undesirable effects there undeniably were as by-products of quick industrialization, but these are far outweighed by the great human gains that have come from the employment of modern machines, the proper use of modern energy sources, and good medical science.

Unlike some of the other revolutionary social changes that we have just considered, this development of pure science and of technology is conservatively based. Science must build on previous scientific fact and theory. The bomb makers of Los Alamos would have been unable to perform their work without a scientific library.

Thus, because of science, we stand on the threshold of a new atomic age that may well bring great benefits to mankind, if such potential human gains are not snatched away by war or a social disorder that may itself be based on an incomplete science of man. More labor-saving devices for brains, as well as for muscles, and a further conquest of human disease and pain certainly and inevitably lie ahead for all mankind everywhere, if man himself does not make this substantial and real progress impossible.

I am not unaware that the picture so far painted in this paper has been done with a broad and coarse brush. Many of its colors and contours might well be modified. Essentially, however, I have attempted to say that physical and organic nature is old and sometimes truly conservative. This often neglected fact may give new meaning

to the words deeply cut in the gray stone of the monumental Archives Building of the Federal Government in Washington: "What is past is prologue." We cannot be as sure as we once were that all change is progress. If social improvement is to be insured, it seems clear that we must review more seriously than we have in the past the psychological and biological presuppositions about man that are basic to some of the more violent difficulties of our present age.

I chose the title "Science and Social Conservatism" for this paper because I am convinced that just such new study of the more enduring aspects of our human world is now needed. In many quarters, the view is gaining adherents that the sympathetic study of religion, philosophy, literature, history, music, and art has been too much neglected in the recent past. There are even those who have made a good case for the fact that some of the deep social and political troubles of the modern world may be traced back to our recent neglect of the classics and of the other humanistic studies. Once again, therefore, it appears that, if we are to attack constructively the problems that face our world, we must examine with care the general decisions that we in our time are making about the education of mankind.

Good education, indeed, may be thought of as just a name for a complex process by which all promising members of each new generation are given, as individuals, the best possible understanding of that which is good and valid in the past and, at the same time, are encouraged to have the desire and wisdom to try to go forward to better things.

We have seen that the social organizations of fossil ants were almost certainly the same as the patterns of active living species of ants today. But man is not an ant. A human innovator is born, and a new idea appears, and a new device is made. The good in such achievements can then, if conditions are favorable, be transmitted to succeeding generations. Thus, mechanical devices, interesting and serviceable ideas, artistic productions, and even spiritual insights arise and become part of our stable social heritage. Once brought into being, these achievements can and do change all lives that later come into contact with them. Because the brain of man makes such quick learning possible, social scientists have correctly emphasized the importance of cultural facts even in the formation of the human personality itself. Prenatal activity, experience in infancy, the nature of weaning, discipline in childhood, attitudes toward other people both before and after adolescence, and hundreds of other facts are now known to react upon those bases of the individual personality that are inborn in order to make each adult human individual what he is.

Anthropologists and psychologists have described and measured many of the basic characteristics of human beings. One result of such studies is the conclusion that, during historical times at any rate, biological evolution has resulted in no fundamental change in man's physiological and psychological capacities or aptitudes. Skeletal remains show that even in recent prehistoric times the variability of measurement of human races in height, weight, and presumably in strength is no greater than is the variability found among individuals in the total human family today. This means that the earliest tools and machines that we know of which were built by men for other human operators had much the same dimensions that they would have today. Maximum and minimum space requirements for the functional use of the body have remained unchanged. The handles of Bronze Age swords fit our hands as well as they did those of their first users.

Further, there is no reason to believe that the acuity of man's senses has changed during the centuries of his life on the globe. All indirect evidence that we have concerning light sensitivity, brightness discrimination, visual acuity, depth perception, and color vision does not suggest any recent biological change in man's visual mechanism. To put this in another way, man is now just as limited by the inborn characteristics of his eyes and his ears as he ever has been, except for the lenses and other equipment that he has built to help them. All this means that, as a receiving mechanism, man is limited by many inborn mammalian characteristics.

Physiological psychologists and human engineers have in recent years also made detailed studies of man's motor skills. Speed of reaction, accuracy of performance, force delivered by human muscles, and the relationships between motor performance, sensory stimulation, and previous learning have all been investigated in some detail. In these studies, there is no suggestion that there has been any fundamental change for many centuries in human beings that can be attributed to organic evolution.

It may be pointed out, however, that better training and better selection of individuals have led to continuous improvement in some aspects of motor performance during recent times. Since 1876, winning marks in national track and field championships have shown continuous improvement. In 1876, the record for the 100-yard dash was 10.5

seconds; by 1900, this had been reduced to 9.8 seconds; the 1953 record was 9.5 seconds. Similar improvements in other skills can be found, but these changes always seem to be attributable not to a biological evolving of better brains and muscles but rather to a more effective selection of athletes and their more adequate motivation, training, and diet.

Thus, in his original nature, each man is limited because he is man. By heredity, he gets his particular sensory capacity, his motor capacity, and the capacity of his own brain to learn. Many other factors that influence his general efficiency in adapting to an old or new environment are also inborn. His ability to withstand alterations of temperature and humidity certainly has changed very little, if at all, in historical times. Drugs that were known to the ancients still have the same physiological effect on modern man that they had then. Tobacco was presumably just as pleasing and just as deleterious to the pre-Columbian Indian as it is to the modern smoker. There is no literature that suggests any change in the implications of the old adage *in vino veritas*.

The immediate span of human memory is definitely limited, as is also the degree to which it can be improved by practice. The number of digits that can be recited immediately after first hearing them differs with age. Two digits on the average can be repeated at 2½ years, 5 digits at 7 years, and 8 digits by the typical college student. There is no reason to suppose that this ability has changed in the past 10,000 years of human life. The effects of disease and malnutrition, except insofar as modern science and modern medicine have modified these conditions, are probably much the same today as in the dim past. Man's need for food, water, air, exercise of his muscles, and the voidance of waste products are probably much the same today as they always were. The same is true also of certain basic aspects of his concern for the reproduction and perpetuation of his species.

Man's capacity to hold data in his mind as he solves problems, or his ability to deal with symbols and words, is on the average no more effective today than it was in classical antiquity. But the symbols that he uses and the rules for their management have been tremendously improved in recent generations.

Hundreds of other specific statements could be brought together to substantiate the view that, although human beings at all times are variable in their capacities, in basic average of abilities or in range of abilities mankind has not altered in any general way during recorded historical time.

In the five or six thousand years, however, that man has been putting down statements about himself and his social life, there has been a tremendous and rapidly accelerating growth in known facts that each new generation of little human brains must master. Thus, today children and university students must be helped by not infrequently somewhat bewildered teachers to deal with mountains of knowledge that did not exist even when our grandparents sat at school or college desks.

This accelerating increase in substantive knowledge has taken place during the very period of the scientific and industrial revolution that we have been considering, and indeed is related to its growth. The piling up of known facts is one of the problems of modern education that has brought about some of its present undeniably unpleasant and undesirable characteristics.

Let us take a few examples. Last year the Smithsonian Institution, which embraces probably the world's largest museum, had 33,184,494 cataloged objects. Some of these are used every day by scores of scientists and scholars to identify systematically new animal and plant forms and new human artifacts. One hundred years earlier this same Institution had 46,000 specimens to be used for these same scientific and scholarly purposes. Today the total number of volumes, manuscripts, and other cataloged items in the Library of Congress exceeds 31 million. Exclusive of periodicals, about 80,000 titles were added to the catalog of the Library of Congress last year. One hundred years ago this same Library cataloged 2328 new titles. In 1850, the British Museum added 14,266 books, but in 1950, the comparable figure was 51,419. In 1852, the Harvard College Library, including the Library of the Medical and Theological Schools, contained a total of 80,000 books. Today's figure is 5,648,748 books.

The growth of research and research publications has been similarly rapid. In 1907, it is reported that 7975 papers dealing with chemical research were abstracted. In 1952, 68,604 abstracts were made and published in this field. President Charles Cole, of Amherst College, in reply to a recent communication, has written:

> My statement on the expansion of historical literature (in the last hundred years) was only a guess . . . But, I said that in the field of history at large the important books (one should read to really know history) had increased ten times. In the field of American history, I am sure it would be at least 20 times.

Similar statements could be made about the increase in knowledge during the past century in almost every important area of study in the physical

and natural sciences, in the social sciences, and in the humanities. This increase in knowledge with which the unchanging brain of man must deal is an important factor in pushing out from established programs of study some of the very subjects which, since the Renaissance, have given many educated men and women a conservative feeling for the great, and, in certain respects, unchanging values of human social living as they are found in the literature of classical antiquity and preeminently in the Bible.

Thus, in a mere 15 decades or so, many new factors have come to influence the intellectual life of biologically old human beings. The industrial revolution was pulling apart some of man's ancient patterns of life at the same time that certain interpretations of science and rationalism were challenging his ancient belief in God and his political acceptance of an organized and stratified society, in which privilege and responsibility were somewhat in balance. As all these mutations were in progress, education was forced to face the problem of passing on to each new generation not merely a gradually increasing store of information but a great flood of new, useful, interesting, but often not well-assimilated knowledge.

One result of all this turmoil of change is that many modern well-educated men and women have come to have inscribed on the most secret places of their hearts the fear-inciting sentence "I do not know what to think." Many such troubled doubters when young received an education that exalted what may be called "value agnosticism." During their educational years, they heard over and over again cynical questions: "How can you prove that this work of art or this musical composition is more esthetically sound than the other?" "Why are the Ten Commandments important?" "Who can say that one religion is more valid than another?" At the same time that this relativism of personal standards was being emphasized, the world was being upset by new political and economic schemes, which at first wore the false face of social and political reform, only later to be unmasked as ruthless dictatorships.

In America at this time, while there was an undoubted improvement in the general standard of living, there was also an increase in crime, in unstable homes, and in the number of individuals who seemed to lead aimless lives dedicated to the pursuit of ephemeral pleasure and not to solid achievement. Even thrift was criticized, and private property became suspect in certain quarters.

Even in 1900, as we have seen, Henry Adams meditated the growing chaos of that quiet day. Now the signs of disintegration are more obvious. What shall we advocate? Shall we ask for a return to some form of authoritarianism in government? In a benign dictatorship, a committee of philosophers might meet behind closed doors and decide for all of us the moral and esthetic values that are to be the law and to be taught to all members of each new generation. This answer is its own refutation. It is part of the glory of a true and free democracy that such a plan is unthinkable in our society.

This brings us sharply back to the one solution that we have already suggested. Education, including full and proper religious education, must, it seems, accomplish the task of bringing order out of the world's present disorder, if it is to be done at all. The alternative to establishing values by fiat, or having no settled values, seems to be that society must do a better job than in the recent past in showing the members of each new generation what the values are that have been judged to be valid in former ages. Thus, teachers must select wisely from the vast and growing accumulation of human knowledge the materials that show how true wisdom of the past has developed and been expressed. Education must make clear how fundamental human and social problems have been solved in other ages. In this way, inventive men and women of the present day will be encouraged to work out for themselves the solution of individual problems and social questions which now puzzle mankind but are often seen, on analysis, to be very old except for the modern costumes they wear.

Science, too, as it learns more about man's inborn nature will help in this process. One of the world's most eminent biologists, G. H. Parker of Harvard, wrote a few years ago:

> I have tried to evaluate that which we have by birth, that which we acquire from social contact, and I have concluded that we are perhaps about nine-tenths inborn and one-tenth acquired.

All biologists and psychologists may not agree with this statement, but the state of science in this area is such that they will find it hard to disprove the assertion. Thus, in spite of the effort of many 19th century reformers to pretend that heredity is irrelevant in human affairs, it now again seems that the very opposite may be true. Man's inborn nature may well turn out to be the most important of facts in formulating a sound personal or social philosophy or in setting up stable political and economic organizations.

The presently known facts of human heredity already make it seem foolish in religious, moral, or esthetic fields to believe that each new generation

can disregard all the painfully evolved experience and wisdom of the past. It would be nonsense for a young physicist to tear up everything in science that has been done since Sir Isaac Newton's time so that he could face modern physics with clear unprejudiced eyes. Is not the same true in religion and in the fields dealing with the social living of human beings?

In summary, therefore, if we are to try to glimpse even some aspects of an elusive cosmos through the chaos of our times, is it not true that we must give full emphasis to all that is valid in the natural sciences and in the social sciences and the applied fields and professions that are related to these areas of study? Above all, however, it would be well to recognize more fully than we have in recent years the importance of vital instruction in the studies that record the most sensitive and subtle solutions of human problems as recorded in all the fields of study we call the humanities.

The methods of learning about values in art, literature, philosophy, and religion are not in all respects the same as those of science. In some of these studies, emotions and attitudes of appreciation and feeling, as well as logic, must be exercised. Thus, at least some of the perceptive members of each generation will gain, as in no other way, an inner enlightened understanding of the personal and social values that have always characterized man at his best and noblest.

In certain respects, man's brain is the greatest and most basic fact in nature. Its capacity, as we have seen, has changed little, if at all, since before Neolithic times. Is it not possible, however, that this conservative and yet peculiarly human organ is still capable of rescuing mankind from the present-day social predicaments (just as it did when history was dawning and *Homo sapiens* first triumphed over his early enemies, the carnivorous beasts)?

Let me end by putting this question in another way: Is it not possible that man's wit, cunning, and intelligence may still be able to save the human species from Henry Adams' chaos? If this is to be accomplished, must we not recognize that, although man is capable of infinite intellectual and spiritual insights, he is nevertheless at the same time an ancient mammal and must of necessity in many ways live conservatively, if he is to be able to gain real personal dignity and true human freedom through membership in a sound, stable, and achieving society?

The trend of the times is toward increasing recognition that the social sciences afford means for better understanding and analysis of many complex social, political, and economic problems. The economists, the psychologists, the statisticians, and members of all the other social disciplines are the specialists whose aid is sought, because theirs is the relevant training. Many organizations offer opportunities for social scientists to work on pressing current problems that call for study by trained personnel. In attacking such problems, at the behest of philanthropic, business, or other organizations, specialists from many fields apply their knowledge and the techniques and theories of analysis that are now available in social science. But all will agree that valuable though such inquiries are—and indeed essential for bringing available thought and information to bear—the complexity of the problems involved does not permit anything more than a partial analysis.—Pendleton Herring, *Annual Report of the President* (Social Science Research Council, 1952–53), p. 10.

Blueprint for Autobahn, U.S.A.

PAUL F. GRIFFIN

Dr. Griffin, assistant professor of geography at Stanford University, received his M.A. and Ph.D. degrees from Columbia University. He was a lecturer in geography at Stanford in 1948–50 and instructor in geography at Columbia the following two years. During 1951–52, Dr. Griffin also served as lecturer for the American Council on Education to United Nations' groups.

IN 1903, the first automobile crossed America at a cost of $8000; the odyssey was inspired by a wager that it could be done in a period of 3 months.[1] The driver won his bet, to the amazement and admiration of Americans.

Since 1903 highways and automobiles have evolved remarkably, but visionaries can anticipate much improvement over the present condition of national highways in even the next decade. The key to vast changes in the future wide-scale, rapid, safe, and efficient travel is the turnpike or superhighway.

Vast as the improvement has been in national roads, there is still much to be desired when these are seen in a national perspective. Basic to this picture are several considerations, including increased traffic, expanded automobile production, and insufficient highway construction.

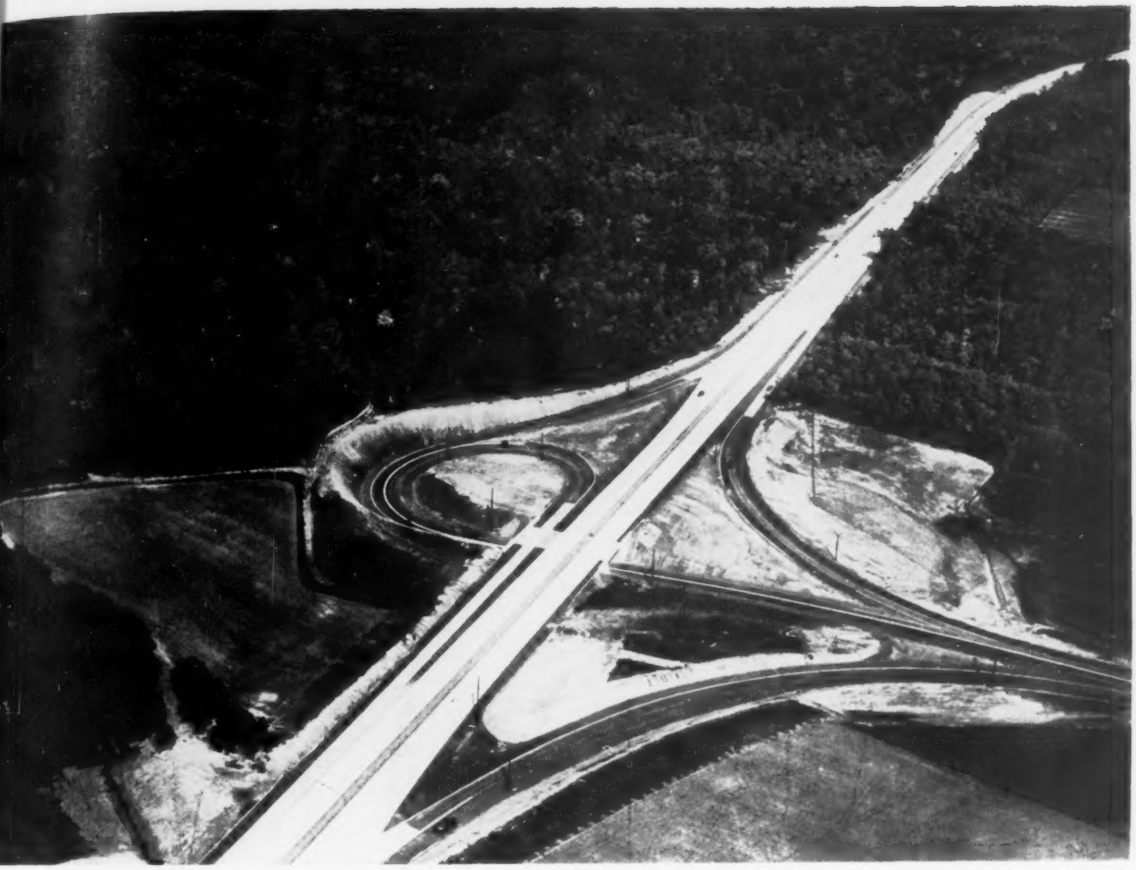
Traffic demands in the United States are growing at such a rapid rate that turnpikes and superhighways have a tendency to become "antiquated" by the time they are finished. More and more it is becoming apparent that four-lane highways are inadequate to measure up to the expanding design of tomorrow's national highway. Superroads consisting of less than six lanes will be forced into eventual if not prompt obsolescence. Congress has estimated that the United States stands some 40 billion dollars behind the times in highway building, and has pointed out with judicial pessimism that by the time we might overcome this backwardness we would be another 15 billion dollars behind the times.[2]

After World War I, automobile production boomed. This industry necessitated road construction at a fairly commensurate pace. But the necessity was not fulfilled, nor is it fulfilled at present, despite the unprecedented zest for superhighways, expressways, toll roads, turnpikes, and similar large-scale routes. A conspicuous need is for large-scale, over-all designing on a national basis. Woodrow Wilson initiated some federal interest during World War I. In 1921, federal legislation provided aid in proportion to 7 percent of each state's rural road lengths. Oregon pioneered with a gasoline tax in 1919, which proved a valuable innovation to highway financing resources, but this, like many other mental efforts expended upon the cause of roads, was on a tactical and not on a strategical basis.

The federal government's interstate highway system now consists of approximately 39,000 miles of interwoven highway systems. This is conceived as a possible tactical answer to the demand for more efficiently linking national highways. It is, however, painfully inadequate in view of present automobile traffic, not to mention demands in the event of a national crisis. Couched in specific terms, what our nation needs in the way of a superhighway is a span of some six lanes stretching from the Atlantic Coast to the Pacific Coast.

The need for nonstop highways is accentuated further by the fact that since 1900 there has been a tremendous growth of metropolitan areas. There are at least fourteen metropolitan districts with a population of 1 million or more that account for almost one-third of our population.[3] These areas represent enormous congestion for through traffic. A few have convenient by-passes (which are met with some resistance by the local business enterprises involved), but the by-pass in itself is an admittedly circuitous route. Much of the national travel time is spent in laboriously negotiating a myriad of traffic lights, areas congested with vehicular conveyances that creep with a molasses-like viscosity, and deviously posted highway signs that require eternal vigilance in order not to miss the road. Each city has its own idiosyncrasies, which must be met by the motorist, or trucker, or bus driver. This point need not be labored further. It is obvious that American *Autobahns* would be a great boon to today's long-distance drivers, and that they will be a necessity of tomorrow.

Another consideration supporting the thesis for



Aerial view of the Blue Mountain Interchange on the Pennsylvania Turnpike System. This is one of 24 interchanges along the 327-mile superhighway. (Pennsylvania Turnpike Commission)

national turnpikes is the technological advance of automobiles. The cruising speed has increased from 25 to 65 miles per hour. On four-lane roads, such traffic is at best hazardous. It is easier (difficult as it is) to design roads from a national master plan than to replace lives lost in traffic accidents.

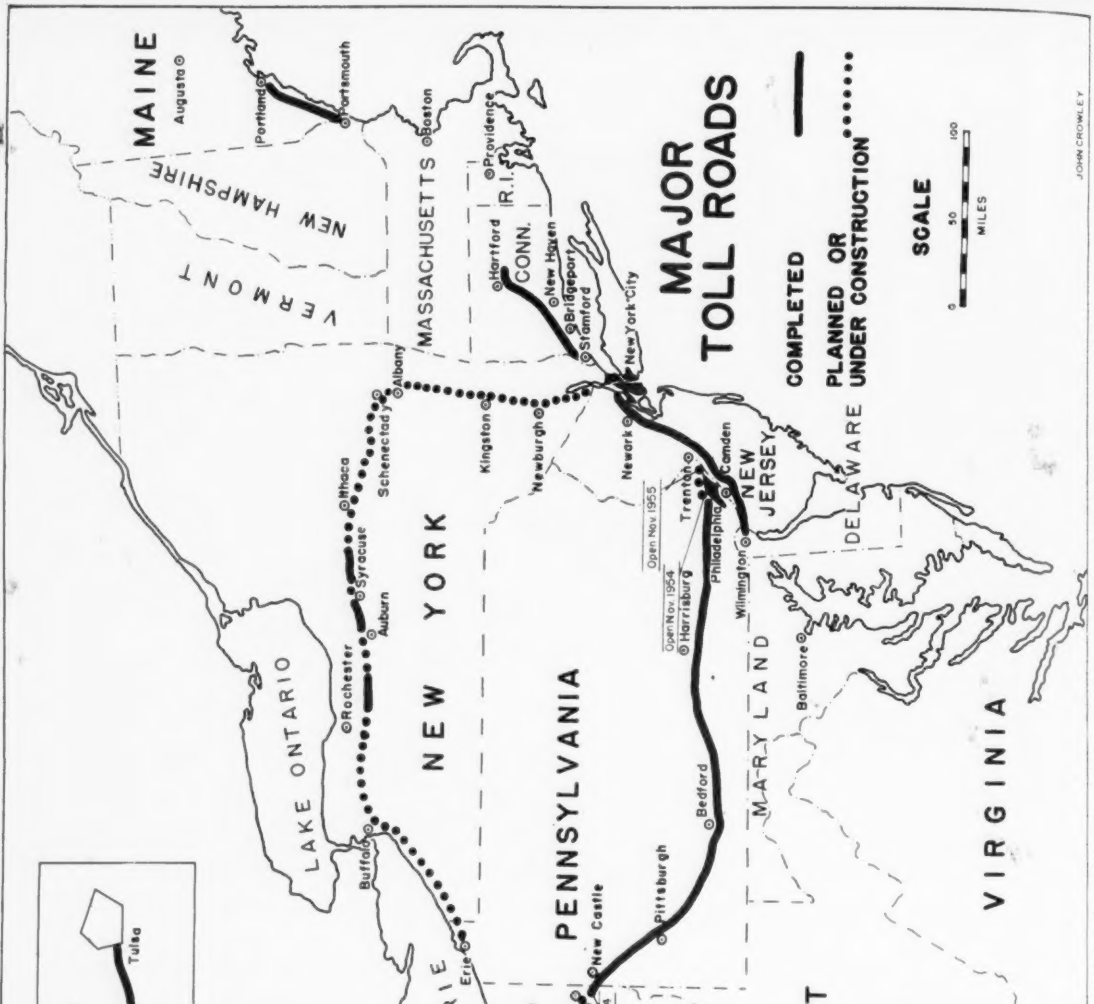
Like tires (with a life-expectancy of around 25,000 miles), roads too have a maximum life-expectancy of 25 years, regardless of surface. This is another consideration fundamental to the design of turnpikes. There are more considerations involved. These include (1) the fulfillment of military demands, which in turn are governed by the stress of international developments; (2) the need to develop better methods for increasing frost-resistance in a national highway that encounters varying terrains and climates across the nation; and (3) the economic element. One of the largest businesses in America today—a composite industry in itself—is tourism. Component parts of this enormous "industry" are motels, roadside restaurants, garages, towing companies, automobile associations, and related enterprises to attend to the needs of a population in transit across the nation.

Although it would seem that the United States, with its increasingly high rate of automobiles, roadways, and tourists, and with the steady growth of the complementary extravaganza of its highways, would be the first country to have met the need for superhighways, it did not initiate this fresh approach to road transportation. The country that actually built the first national superhighway had a different reason for undertaking the project.

Autobahnen: First High-Speed National Road System

Hitler early recognized the need for a national system of military superhighways. He personally turned the first spadeful of dirt for the *Autobahnen* in 1933, 4 years before the Pennsylvania General Assembly created the Pennsylvania Turnpike Commission. Neither *Anschluss,* the Czechoslovak grab, nor construction of the Siegfried Line was permitted to interfere with the road building.

From Berlin, the center of the *Autobahnen,* roads were built to Falkenburg, which is within 95 miles of the Polish Corridor, to Hamburg in the northwest corner of the Reich, to Saarbrücken on



Some of the major toll roads in the United States, completed, under construction, and planned in 1954.

the French frontier, to Munich in the south, and to Vienna in the southeast.[4] By 1939 Germany had completed 1900 miles of superhighway. German road-building enterprise did not stop within the borders of the Third Reich, but, with typical thoroughness, extended into Czechoslovakia, and into that state's autonomous component parts: Czechy, Slovakia, and Carpatho-Ukrainia.[5]

Slickly engineered, with a minimum of turns and steep grades, the twin three-lane strips of the *Autobahnen* are separated by a hedged and grassed parkway 16 feet wide, which keeps traffic separated and cuts down headlight glare. Underpasses, overpasses, and cloverleaf patterns provide for maximum speed and maximum safety.[6] Service stations, hotels, repair shops, and rest stations are spaced along the highway with Teutonic regularity (26 miles between filling stations).

Much more than speedways for vacationing Nazis, the *Autobahnen* were designed for their potency as a military aid. Logistics experts calculated that soldiers with all their impediments could be trucked over any stretch of the system, using only one strip, at the rate of 72,000 persons an hour.[1]

Postwar European Highway Developments

Twelve European countries, from both sides of the Iron Curtain, and the three western zones of Germany have approved a draft convention on roads which will be of the greatest importance to continental travel and trade. It deals primarily with the construction of new highways, establishment of an international highway code, and the easing of customs restrictions.[7] The draft plan approved by the subcommittee on roads calls for a 26,000-mile network, linking all the principal cities of the continent. It is to run from London to Warsaw, from Bordeaux to Belgrade, from Oslo to Naples. In the main, the international highways will follow existing roads, but much construction to join up the different systems will be required. Where necessary, present highways will be developed to conform to one of three road categories, having two, four, or six lanes, respectively, and varying in width from 7 to 10½ meters.[7]

Essential Problems of American Motor-Vehicle Transportation

Writhing across the United States today are more than 3 billion miles of rural roads and 319,000 miles of city streets. More than 50 million motor vehicles, of which more than 9 million are trucks and buses, use these roads. Annually these vehicles travel 340 billion passenger-miles and carry 130 billion ton-miles of long-range freight. This is twice as much traffic as was carried by motor vehicles 15 years ago, and the traffic is increasing steadily at a rate that will double the present number in the next 10 to 15 years. One passenger car for every 3.5 persons and one truck for every 18 persons of our population have made us a nation of famed automotive abundance. One worker out of seven gains his livelihood from some branch of automotive transportation.[8]

The Toll Road: State's Solution to the Problem

State toll-road and superhighway building actually got underway in the United States about 1937. During that year the Pennsylvania General Assembly created the Pennsylvania Turnpike Commission, empowered to build and finance a self-liquidating superhighway from Harrisburg to Pittsburgh.

Nothing short of a diastrophic movement could have compared with the record-breaking earth-movements that took place between 1938 and 1940. Engineers, draftsmen, mechanics, clerical, and other technical workers swarmed over the changing face of Pennsylvania like eager ants at an exploded granary.

Constituting one of the largest engineering problems were the massive Appalachian Mountain ridges across the central part of Pennsylvania, stretching from New York to Georgia. Around 2500 feet in altitude, they necessitated the use of seven railroad tunnels, the longest of which was Sidelong Hill (6782 feet).

It has been significantly asserted:

> The Commission considers the Turnpike as the "yardstick" of all superhighway building in the future. Its construction involved every known principle of engineering skill. Many new ideas were tested and used. If and when the Federal Government decides to undertake the construction of a national network of superhighways, the Pennsylvania Turnpike will be its first link.[9]

Since that all-important turning point in 1937, turnpike trends have swept the country. Maine started the postwar turnpike construction boom with a toll highway from Portland into New Hampshire. Pennsylvania has extended its turnpike from Harrisburg to Philadelphia, now traversing the length of the state. Other toll roads, expressways, superhighways, and parkways came into being, such as Connecticut's Merrit and Wilbur Cross Parkways, Maine's Turnpike, New Hampshire's Turnpike, New York's Saw Mill River Parkway, and the Hutchinson River Parkway.

Today, toll roads already in operation, under construction, approved or proposed, total 6000

The Pennsylvania Turnpike wending its way through picturesque Bedford County in the heart of the rugged Allegheny Mountains. (Pennsylvania Turnpike Commission)

miles and involve 26 states: Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Virginia, Washington, West Virginia, and Wisconsin.[10]

In nine states, individuals or agencies already have authority to build toll roads at will. In some, a highway department legally can designate toll routes as it pleases. In others, only the governor's approval is needed.

Major Developments in State Toll Roads

New Jersey Turnpike. New Jersey serves as a corridor between New York, New England, and the South. Through the most congested areas in the world, it has finished building a 250 million dollar modern speedway, which stretches for 118 miles, from the western approach to the George Washington Bridge on the Hudson to the eastern end of the Delaware Memorial Bridge at Wilmington. Maximum grades are no more than 3 percent, and the curves are wide, easy sweeps. There are no stop lights, no crossings, no left turns on the road. Traffic moves over this speedway at an average of 60 miles per hour. The full-length toll is $1.75 for passenger cars, with a minimum of $4.50 for trucks. Seventeen interchanges (entrance-exit points) allow local, as well as through, traffic to use the new road.[11]

New York State Thruway. The New York State Thruway, now being constructed, is the longest of the nation's ever-growing family of limited-access toll highways.[12] It will span the Empire State westward from Albany to Buffalo and beyond to the Pennsylvania border, and from Albany southward to New York, a total distance of 500 miles. Barring unforeseen events or further shortages of steel, the New York-to-Buffalo route is scheduled for completion late in 1954.

Originally conceived as a free road, then as a facility to be paid for through the sale of annual user permits, the Thruway is now being constructed as a toll facility of the interchange type with variations. New York-registered passenger cars will have an annual permit allowing unlimited use of the roadway without additional fees.

Ohio's Superhighway. Ohio has raised 326 million dollars in bonds from United States investors to finance the building of a 241-mile superhighway across the state, from the western terminus of the Pennsylvania Turnpike to the Indiana border.[13] After a 35-mile Philadelphia by-pass links them, the Ohio Turnpike will provide a superhighway route enabling motorists to drive from Hartford, Connecticut, as far as Indiana, at high speeds, with few toll stops and no traffic lights. When additional New England toll roads are completed, interlinked highways will reach from Portland, Maine, to Chesapeake Bay and Washington, D.C.

Other Significant State Developments

Indiana plans for a 150-mile toll superhighway across the northern part of the state—an important link in a chain of toll turnpikes carrying traffic between New York and Chicago. Construction is scheduled to begin early in 1954.

Kentucky is making surveys for a 22-million-dollar highway from Louisville to Elizabethtown, with plans for ultimate extension to Nashville.

Maine hopes to project a 60-mile extension from Portland north to Augusta.

Massachusetts is preparing for an east-west cross-state toll highway expected to cost approximately 20 million dollars.

Wisconsin has submitted a bill for a 175-million-dollar toll road across the state to speed traffic between Chicago and the Twin Cities.

Alabama proposes a 100-million-dollar toll highway from Decatur through Birmingham to Mobile.

Colorado's new Denver-Boulder toll road has been traversed by more than 2 million vehicles since its completion. The state is now preparing legislation to finance a toll highway tunnel at one or more sites under the Continental Divide.

Florida plans a north-south tollway running through central Florida, a distance of 362 miles.

New Hampshire is thinking in terms of a 40-million-dollar toll superhighway for the central and eastern part of the state. The plan would provide for a 40-mile highway from the Massachusetts border to Concord and an extension of the present New Hampshire Turnpike from Portsmouth to Rochester.

Is the Toll Road the Answer to Our Highway Needs?

Those ubiquitous personages, the tax collectors, are taking over our travel facilities. Nine states, mainly in the East and Midwest, already are grabbing coins from motorists. Seventeen others have approved or proposed pay-as-you-ride highways.[10] The public and the victimized motorists overlook the fact that they have already paid in advance for toll roads through gasoline taxes. The Federal Bureau of Public Roads claims that states have used 3 billion dollars of motorists' taxes for other purposes as far from road building as the mind can imagine.

In 1951, out of every dollar that poured into state treasuries in the highway-use taxes, only 53 cents went for administration and tax collection costs, to state highway police, and for payments to holders of highway bonds. Yet in that year, states diverted 266,771,000 dollars to other purposes.[10]

Building a toll road is not like building a free road. Often, it is 3 or 4 times costlier. First, consider the financing. Instead of paying for the roads out of their own treasuries, the states borrow the money. To attract investors, they pay high interest rates free of tax, thus making the mass of taxpayers carry the burdens. Second, toll roads are more expensive to build, since they call for the building of costly overpasses to prevent free access to them. Third, hundreds of employees must be hired to man toll booths day and night.

The toll road essentially is designed to provide rapid highway transit for through or long-haul traffic, but most of the nation's traffic is short-haul

The imposing Susquehanna River bridge at Harrisburg, one of three major spans on the 327-mile Pennsylvania Turnpike System. (Pennsylvania Turnpike Commission)

TABLE 1. Speed limits compared with traffic death rates in several states.

No. states	Speed limit (mi/hr)	1950 traffic death rates per 100,000,000 vehicle miles
1	40	4.2
3	45	4.5
12	50	6.7
7	55	8.1
14	60 and over	7.7
11	No limit fixed	8.2

TABLE 2. Accident-death chances at various speeds.

At a constant speed of (mi/hr)	One can drive 400 mi in	But if an accident occurs, the chances of someone being killed are
45	8 hr, 54 min	1 in 16
55	7 hr, 18 min	1 in 12
65	6 hr, 10 min	1 in 6

in nature. Origin-and-destination surveys made at cities of various population groups show that, on the average, 95 percent of the traffic approaching a city of more than 500,000 population is bound into, and not beyond, the city, and nearly 20 percent is bound into the central business district of the city. Even at much smaller cities, those of 25,000 to 50,000 population for example, an average of about 80 percent of the traffic has its destination in the city, and in this case about one-third is destined for the central business district.

Solution of the traffic problem can lie only in an enlargement of the capacity of the city arteries themselves. Toll roads make no provisions for such problems in metropolitan districts. Free roads, on the other hand, would permit unlimited access of urban traffic to main thoroughfares.

Traffic studies along the New Jersey Turnpike further document failure of the toll road to eliminate traffic congestion on parallel routes where congestion was most serious. On U.S. highway 1 in Newark, during 1951 there were 86,600 vehicles per average annual day.[14] Now with the Turnpike parallel and about ½ mile away, there are still 73,000 cars daily. Based on other volume increases in the area, a normal growth increase of 4400 cars per average day can be expected. In 2 or 3 years, highway 1 will probably be as congested as it was in 1951 through this area.

Superhighways Have Poor Accident Record

Superhighways, built to eliminate most driving hazards, have created hazards of their own. Chief among these is speed. Still the number one killer on all roads, it is an even greater menace on the superhighway. Without traffic lights, crossroads, sharp curves, or steep grades, the motorist can zip along at a rate he has never dared before. Chances of an accident caused by speed are, therefore, much greater.[15]

The much-heralded Pennsylvania Turnpike, with a present speed limit of 70 miles per hour, has a death rate of 8.0 per 100 million vehicle miles. The 70-mile speed limit has proved nothing short of legalized murder and suicide. Motorists attempting to drive that fast or faster have been responsible for a great many of the 398 deaths that have occurred on the pike since it was opened in October, 1940. In 1952, 83 persons lost their lives on the pike, an increase of 17 over the previous year's death toll.[16]

The New Jersey Turnpike, with a speed limit of 60 miles per hour, has a death rate of 6.5. New York State, with a legal speed limit of 50 miles per hour on its state highways, has a death rate of 6.0. On the Long Island parkways, where the speed limit is 35 miles per hour in Brooklyn and Queens and 40 miles in Nassau and Suffolk Counties, the death rate is one person per 100 million vehicle miles.[17]

The New York Good Roads Association has compiled the data in Table 1.[18] The lesson is obvious. Additional ramifications are shown in Table 2. The interesting data were prepared by the National Safety Council.[17]

A second danger that faces the motorist on the superhighway is "high-speed hypnosis,"—a trance-like state induced by mile after mile of effortless driving. In its acute stage, it may become actual dozing. In its more insidious form, it is a temporary loss of alertness.

A third hazard is that speed increases the danger of accidents caused by the weather, mechanical failures, and the unpredictable notions of other drivers. Most of us simply are not constructed so that we can come from months of driving at speeds of from 25 to 55 miles per hour and then suddenly drive at upward of 70 without greatly increasing the danger of accidents.

Need for a National System

Past mistakes of main road location, building, and neglect are understandable, but their consequences today emphasize the need for designating and preferentially improving a national system. Modern traffic obviously calls for larger and more national over-all strategic planning. Consider the figures for vehicle registrations during 1950 as com-

pared with those of 1945. Increases of nearly 60 percent were registered in 1950, at which point 48,283,335 vehicles were registered in the United States. This growth is only an index to the number of road-miles covered by vehicles today in the nation—which calls for greater *Autobahns* than ever before—either in time of national crisis or during peace.

The United States has no really modern highway in operation and certainly has no valuable highway from the East Coast to the West Coast in time of war. There is no provision for the conversion of major highways into military supply or reinforcement channels if the need arises. Neither is there a plan in operation that could convert our highways into landing fields for fighter planes to strenghten our defense in key regions during time of war. In the event of an atomic attack, there are no facilities for moving masses of people or military supplies out of congested areas. This is not to mention the inadequacies of our transportation system to meet the needs of everyday travel.

American highway construction, for the most part, has followed a system of jerrybuilding. The pattern has developed largely from local needs and has evolved successively from the buffalo trail and the Conestoga road to the turnpike and military road, and finally to the superhighway with no eye toward the solution of the main national problem. These old roads cannot be reconstructed to handle the flow of modern traffic. To date, the superhighway is only a coarse net to connect the nodal points in a national system. The need is for a network of national turnpikes with four or five big channels stretching from the East Coast to the West Coast, traversable under all weather conditions and connecting key regional centers.

Obviously, this proposal calls for a revamping of highway financing, which presents many complex facets. The individual vehicle owner has been taxed via license plates, gasoline prices, driver's licenses, insurance, and tolls. Have these taxes paid for the right kind of highways? Can individual states, with their great differences in size and wealth, maintain equally the types of highways needed to solve our traffic problems? In connection with the toll roads, is the charge for highway use proportionate to the extent of the user's benefit from it? Have toll roads been built with proper safeguards to prevent them from being tolled after the justification for operating them as such has discontinued? This aspect deserves thoughtful evaluation. Judging from assertions made editorially in the *Engineering News Record*,[19] much remains to be examined in this respect.

The answers to these and many other questions must be found and put into practice before we can expect to solve the innumerable problems facing American vehicular transportation today. The central appeal is for a shift in design from the regional to the national need. This can be achieved by federal visionaries whose horizon is not bounded by city-to-city or regional exigencies.

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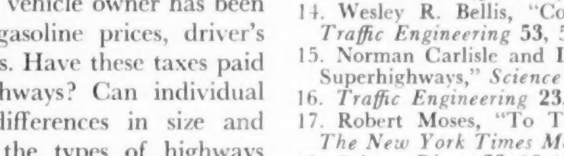

BOOK REVIEWS

Oil in the Soviet Union. Heinrich Hassman, translated from the German by Alfred M. Leeston. Princeton, N. J.: Princeton Univ. Press, 1953. xvi + 173 pp. + maps. $3.75.

HERE is a book of interest to all who are concerned with the role of raw materials in world politics. Part I, "The Basis of the Russian Oil Industry," is a fifteen page primer covering the economic geography of the U.S.S.R. and the impact of the Soviet economic system on the development of natural resources. Here, as elsewhere in the volume, events and conditions following the October Revolution are accorded a dispassionately dead-pan evaluation which gives voice to no partiality, one way or the other. Part II, "Development of the Russian Oil Industry," opens with a discussion of the industry under the czars and traces the history of development of the Azerbaijan (Baku) area to world leadership in production in the decade prior to World War I, largely under the influence of foreign capital. The advent of the Soviet regime precipitated a brief occupation of the Azerbaijan area by foreign troops. The author points out that after reestablishment of control and expropriation of the industry the problems faced by the Soviets were dominated by the demonstrated danger of reliance on the exposed Baku area and the necessity of developing an integrated oil industry without the technical assistance formerly supplied by foreign interests. These problems were partially satisfied by development of interior producing areas (the "Second Baku") on the flanks of the Ural Mountains and by the establishment of refining and transportation facilities, geological and geophysical surveys, and technical training centers. These efforts raised Russian oil production to about fifteen percent of the U.S. figure by 1950 but the reader is unable to estimate the cost to the rest of the Soviet economy.

Part III, "The Regions of the Soviet Oil Industry," is devoted to brief sketches of the oil-producing areas, with numerous maps which, unfortunately, fail to indicate the positions of the fields discussed. American oil men will note an apparent parallel between the great "Second Baku" areas and our own midcontinent districts and will consider with envy the huge Asiatic basins between the Urals and Sakhalin Island which, by our standards, seem scarcely to have been scratched by exploratory drilling. In Part IV, "Problems of the Russian Oil Industry," the author has drawn a skillful contrast between the analysis of production figures as applied to a highly motorized people living under a free economy and dependent on highway transportation, and a bureaucratically controlled people living in a rigid economic framework which permits no nonproductive use of petroleum. Nevertheless, it is pointed out that growth of a petrochemical industry, continued mechanization of agriculture and the armed forces, and the emergence of motor transport combine to lay an increasing responsibility on the oil industry. The author raises, but leaves unanswered, the question of whether the Soviet oil industry, with the help of imports from satellite countries, can continue to satisfy an expanding demand for petroleum and petroleum products. The answer to this question, in Hassman's opinion, will be the controlling factor in Russian policies toward the oil-rich areas around the Persian Gulf.

The reader is seldom aware that this book is a translation. Further, the translator has brought many of the statistics up to date by inclusion of 1952 figures and has added numerous footnotes covering materials that have come to light since the original German publication. There is little comfort in this volume for those who take refuge in the belief that the Soviet Union has neither the natural nor human resources to establish the industrial sinews of war.

L. L. Sloss

Department of Geology
Northwestern University

A Field Guide to Rocks and Minerals. Frederick H. Pough. Boston: Houghton Mifflin, 1953. xv + 333 pp. Illus. + plates. $3.75.

THIS attractive pocket book of mineral identification promises to win many new devotees to mineralogy. Frederick H. Pough is adequately qualified to write for the amateur, the serious collector, the naturalist, and the beginner in mineralogy. His training and experience were acquired in this country and in Europe at three universities and as curator of Mineralogy and Physical Geology, American Museum of Natural History. This is the first simplified book on minerals to be extensively illustrated with photographs—254 of them, 72 in gorgeous colors. Most of these are photographed from specimens in the collection of the American Museum of Natural History and make the mineral descriptions vivid and alive.

The book is divided into two parts. Part I consists of six chapters. Chapter one outlines mineral collecting, collecting and testing equipment, reagents and laboratory supplies. Chapter two is concerned with rock classifications and mineral environments. Chapter three describes rock and mineral textures and the physical properties of minerals. Chapter four presents the six crystal systems and concepts of twinning, crystal habit, and pseudomorphs. Chapter five gives a chemical classification of minerals. Chapter six describes blow pipe tests, technics, and a suggested testing procedure. Part II gives the mineral descriptions of some 250 minerals that the nonspecialist is most likely to collect. A glossary of terms, a bibliography, and effective endpaper diagrams are included.

It is possible that the publisher and the editor of the field guide series have allowed their enthusiasm for this splendid book to carry them a little too far. On the front inside flap of the jacket is printed that this book

is complete enough to satisfy the demands of both the amateur and the professional." The editor's note states that "Many new and relatively simple tests are described. . . ." The author's statements in his preface do not agree with this, for he states that "the book is not intended as a textbook of mineralogy . . . " and in its preparation "an attempt has been made to simplify the identification of minerals for the collector and to give as much information as possible to help the beginner form the habit of observing and testing." In regard to tests he says: "Many observations are included which are either original or have been forgotten in the half-century since blowpipe and chemical testing were in good repute."

As this is intended to be a practical book, a word of caution should be included on attempting to classify rocks from colored photographs. Beginning students wish to name rock types on the basis of color, such as white rocks are granites, pink are syenites, and gray are diorites, but granites may be white, pink, gray, or yellow brown, as this book mentions, and the only correct way to classify them is on the basis of mineral composition and texture.

The main contribution of this book lies in the compiling and compressing of so much authoritative information and so many stimulating illustrations in so small a book. More information on testing minerals with ultraviolet light is given than appears in many texts on mineralogy, but this is easily understood because of the popular appeal that the method has enjoyed in museums. Doctor Pough is to be congratulated on producing a book on minerals that has long been needed if one can judge from the phone calls and letters that reach a typical geology department requesting the name of a simple book on minerals.

VICTOR T. ALLEN

Institute of Technology
Saint Louis University
Saint Louis, Missouri

Climatic Change. Harlow Shapley, Ed. Cambridge, Mass.: Harvard University Press, 1954. xii + 318 pp. Illus. $6.00.

WHY the average conditions of weather will change for hundreds of years at a given place on the earth's surface constitutes one of the mysteries that have intrigued scientists ever since it was first established that ice ages and periods of warmth and lush growth have left indelible records in the rocks of our planet. Living things in the sea, in passing, left behind thick deposits of lime and silica, and storehouses of raw petroleum chemicals. On land, forests of tree ferns and ancient relatives of the modern ground pines and horsetail rushes transformed sunlight into the fossil fuel which we mine as coal. By way of contrast, there were other lengthy periods scattered throughout geologic time, when vast deposits of ice grew year after year to cover millions of square miles, to over-ride all but the tallest mountain peaks, to sweep all living things before it, and to alter continental topography as no other erosional agent is capable.

This book is an outgrowth of conferences held in Boston, during May 1952, at the American Academy of Arts and Sciences. Climatic experts, covering many scientific disciplines, assembled for two days of comprehensive searchings among current knowledge and theories on world climatology. As Donald H. Menzel, Harvard astrophysicist, stated in discussing causes of the ice ages, "We have too many theories, almost any one of which sounds plausible on the basis of qualitative reasoning." The meetings were exciting at times, with all sorts of bizzare ideas tossed into the arena for verbal dissection. Not all managed to survive in the light of sober re-examination or under the editorial crayon of Dr. Shapley.

Think of almost any explanation for the onset of an ice age, and the chances are it received some consideration. Variations in the heat of the sun producing weather that was on the whole "colder than usual" or "warmer than usual"? Yes, both hypotheses had their champions. Sunspot cyclists, varying from the familiar 11-, 23-, and 50-year proponents to those who assert there are super-cycles covering many thousands of years, have their say on the record. Magneto-hydrodynamic theory stands beside the increasing evidence of fluctuations in visible solar radiation. About the only speculations omitted were those of worlds in collision or of polar shifts, supposedly owing to an earth "careening" under the weight of polar ice—ideas containing much imagination but very little evidence. There can be practically no argument, however, with the thesis used by Harry Wexler of the Weather Bureau, that whenever climatic changes result in vast quantities of the earth's water being locked up in cold storage for ages, the energy involved or the lack of it is owing to variations in the amount of solar radiation. Further, as Barbara Bell points out, any satisfactory theory will have to account for a change of more than 50 degrees Fahrenheit at the poles, and only a small change at the equator.

Richard Foster Flint presents the geologic evidence —measurements on existing glaciers, and geologic studies of glaciers that have disappeared—to show glaciation's periodicity through the ages. The part played by interstellar matter, its tendency to aggregate into clouds and the effect this has upon the solar constant, is considered by Max Krook. Dirk Brouwer and A.J.J. van Woerkom of Yale conclude that changes in insolation owing to changes in the earth's orbit or in its axis of rotation are insufficient to explain glaciation.

Carleton S. Coon offers one of two essays on the ecological adaptations of living things to climatic variations by commenting on "Climate and Race." The other on "Climate and Civilization," is the work of Paul B. Sears, Yale biologist. All told, there are twenty-two contributors to this volume, including Dr. Shapley who establishes the essential conditions which must be present before life is possible on a planet. Some of the authors write in two or three fields.

The book achieves a purpose for which the director-emeritus of Harvard College Observatory has become famous. It presents a broad examination of an important scientific question by mass attack from many directions, from paleodendrology to celestial mechanics, from physiology to astrophysics. For years to come this will be a standard reference book whenever a weather eye takes a long-range look. Many of the articles are obviously directed toward laymen, a few are technical masterpieces.

HERBERT B. NICHOLS

U.S. Geological Survey
Washington, D. C.

The Major Features of Evolution. George G. Simpson. New York: Columbia Univ. Press, 1953. xx + 434 pp. Illus. $7.50.

IN *The Major Features of Evolution,* completed in 1951, George Gaylord Simpson extended the creative scope of his classic work, *Tempo and Mode in Evolution,* completed in 1942. During the six intervening postwar years so much new material had appeared that an entirely new book was indicated. As both books show, Simpson has taken a restricted science, long confined within its own boundaries, and revitalized it by applying to it principles derived from other disciplines, notably biology and its branches, ecology and genetics. Biology is experimental. By definition paleontology is not. Simpson gives fossil bones the benefit of experiments on living organisms. His revelation of some of the natural rules governing evolutionary change has in turn supplied biologists with new materials and new ideas, and has also guided the thoughts of many physical anthropologists who have read *Tempo and Mode* widely, and who will no doubt spend many long evenings struggling through the muskeg of terminology, with which the present work is coated, to reach the pole of original concepts that lie beyond.

We wish that it were possible to do away with the welter of Greek terms, which no Greek would understand. One's fingers itch to rewrite parts if not all of this book so that educated laymen as well as average scientists could get through the average chapter without recourse to both Liddell and Scott and Webster's Unabridged. Being a truly great book, it deserves a wider audience than the few who will really undertsand it and the far wider circle of academic sycophants who will pretend such comprehension in foggy realization of its significance. For Simpson is by the same token a coordinator of scientific fields—one of the few men living who can leap the wall of entrenched disciplines—and an originator of ideas, causing science to move rapidly by saltation, and detonating explosive evolution in scientific thought.

As coordinator, he faced the task of equating what different men mean by the term *species*. Some use behavioral criteria, such as interbreeding; others rely entirely on dead anatomy; still others work on a personal, intuitive, or aesthetic level. By hard work and good judgment he has hammered these three into a common framework, to which he then applied his world-wide and time-wide treatment of population statistics. He has plotted the numbers of individuals, groups, and species and their geographical ranges against time. The result is a dynamic picture of evolution in which biological principles are invoked to explain rapid change, lag, and extinction.

A proper balance is drawn between the adaptation of the phenotype and genetic change, in which a capacity for individual variation is recognized as a vital hereditary factor which makes survival possible under conditions of environmental change. He invokes the work of Mayr and Rensch in ecological adaptation and refers to the long but little known rules of Bergmann and Gloger referring to the relationships of sizes and surface colors of animals to variations in temperature and light. He is in my opinion too cautious about the reason for the black skin of hairless desert animals, like man, for Luckeish has shown that melanin converts the harmful portion of the U-V spectrum into radiant heat, but this is a small detail.

Simpson evaluates the role of genetic drift in the evolutionary process. He straightens out the current confusion about pre- and postadaptation by explaining how a species crosses an adaptive threshold—a point at which it is adaptive to both old and new conditions in a state of instability. He then introduces the concept of quantum evolution by which such thresholds are reached and crossed. This is but a small fraction of the ideas thrown off, like the reproductive cells of codfish, in this exciting and original, if difficult, book. Get out your dictionaries in two alphabets, and you will not regret the effort.

CARLETON S. COON

The University Museum
The University of Pennsylvania

Geography in the Twentieth Century. 2nd ed. Griffith Taylor, Ed. New York: Philosophical Library; London: Methuen, 1953. xi + 661 pp. Illus. + plates + maps. $8.75.

FOR three decades Griffith Taylor has been one of the brilliant minds in the field of geography—first in Australia, then in the United States, and later in Canada. Whether or not one agreed with him, he was always provocative. Taylor's interests are broad; his geological background prompts him to start each landscape study with the pre-Cambrian, and his anthropological concern leads him from geography into racial theories. A score of volumes have come from his pen.

Geography in the Twentieth Century is a symposium by twenty-two authors in five countries. Taylor has contributed six chapters in which he makes very clear his concepts as to the importance of environment; in fact "he is himself quite willing to be classed as one of those geographers who is to some extent tarred with the determinist brush." In the preface, Taylor writes "Geography may be described as the discussion of the *causes of patterns of distribution.*" Not all of the contributors

share his philosophy, but his various chapters keep the discussion on the track as he sees it.

Six chapters are devoted to the evaluation of geography and its philosophical base. Ten more deal with the environment as a factor in human affairs. Then follow a dozen chapters on special fields such as political and cultural geography and cartography. Much of the material is "practical" in that it relates geography to land planning, exploration, or government services. Several chapters consider the evolution of geography in Europe. Others survey the development of meteorology and climatology. Settlement is considered in several areas from the arctic to the tropics.

One chapter by Taylor is devoted to "Geopolitics and Geopacifics," two words which stand in some antithesis. The latter is "an attempt to base the teachings of freedom and humanity upon real geographical deductions. . . . It shows for instance, from a study of the World Plan, where the leading nations must arise. . . . It explains the realities of climatology with a view to aiding the World to improve the better portions of the World first; instead of encouraging wasted efforts whereby folk are urged to develop difficult terrains, when easier lands are available near at hand."

Geographers may properly recommend this volume to their colleagues as presenting *one* approach to geography in the midcentury. For a fuller and perhaps more representative survey, *Geography in the Twentieth Century* should be matched against *American Geography, Inventory and Prospect*, published by the Association of American Geographers to mark their fiftieth anniversary in 1954.

GEORGE B. CRESSEY

Maxwell Professor of Geography
Syracuse University

From Fish to Philosopher. Homer W. Smith. Boston: Little, Brown and Co., 1953. 264 pp. Illus. $4.00.

"THE history of the earth and the history of life are as a die and a mold." Both the history of the earth and the mechanism of evolution are lucidly sketched in a fast-moving style that even the nomenclature of palæontology fails to hamper. One glimpses: the glomerular kidney as a release from the waterproofing armour of the Devonian fishes; the loss of glomeruli by many fish permanently resident in the sea (osmotically a dry place for fish); the "ingenious" urea retention device of elasmobranchs for osmotically holding water in their tissues; the control of kidney filtration rate and skin permeability tried by the Amphibia; the significance of the elaboration of uric acid by birds and reptiles for their ability to live on land; how each metabolic device to increase the range of conditions an animal can tolerate brings with it modifications of the reproduction to protect eggs and embryos from conditions the adults can endure; for example, the shelled eggs of sharks, the aquatic larvae of Amphibia, the invention of the amnion (private pond) and feeding membranes by reptiles, birds, and mammals. Finally, the evolutionary accident of high blood pressure accompanying the warm blooded habitus of mammals increased kidney filtration rates enormously (190 quarts per day) and developed tubular reabsorption to the point where huge amounts of blood are treated (40 times as much as goes to most organs of comparable size), producing an extremely sensitive regulation device which, by implication, is responsible for the speed and precision of mammalian nerves and muscles.

Because Dr. Smith feels that consciousness is one aspect of the play of patterns of action through a nervous system adapted essentially to the control of bodily movement, it follows that the sensitivity of the kidney as a regulatory device is directly responsible for the "intensity" of human consciousness and thereby for his self-consciousness and status as a philosopher.

The removal of much of the technical discussion to the bibliography has greatly added to the readability of the book, and classes should find it easy to use as a gateway to some of zoology's most pressing problems.

It would have been desirable to see some account included of the sensory-motor activities (and others) of the brain which are altered by changes in some of the blood constituents regulated by the kidney. Nevertheless, in a field so broad, so boldly sketched, some points of disagreement will occur to every reader, but whatever they may be, the author has earned once more our warm appreciation for the production of a work of that synthesising nature which has not been too common in American scientific literature.

W. B. STALLWORTHY

Mount Allison University
Sackville, N. B.

The Achievement Motive. David C. McClelland *et al.* New York: Appleton-Century-Crofts, 1953. xxii + 384 pp. Illus. + plates. $6.00.

THIS report of a five-year study by four of the younger generation of psychologists furnishes an interesting example of research under way: theories remain theories, and experimental procedures as well as empirical results are recognized as calling for continuous reappraisal. Here is not final settlement of questions, no ultimates. But here is a refreshing presentation of prolonged inquiry in which theoretical speculations and experimental findings interpenetrate and interstimulate, as the investigators press on in their quest.

The general problem is, can we number among the human motives—in the technical sense, now—the "seeking to achieve"? A rather prolonged theoretical consideration of the concept of motivation introduces the experimenal studies. On its own account, this motivation theory is profitable reading for the psychologist who would keep abreast in this area.

The experimental work was directed at the problem whether a person's motive "to achieve" can be brought to light in his fantasies, and can be measured in its strength. The procedure was an adaptation of Murray's Thematic Apperception Test, and as a form of pro-

jective technic, it may be expected to bring to light motives that are operating in the subject's free thinking (fantasy). A picture was shown student subjects on a screen, and they were instructed to write a short story about it. Then to what extent did the characters in the imagined story reveal motives to achieve? Were they engaged competitively? Were they striving toward some standard of good performance? Further analysis was directed by such questions as: Do the characters seem consciously aware of a drive to achieve? Do they seem to be expecting to succeed or to fail? Are they experiencing positive or negative emotions in connection with their work? The positive counts on these and like details were totalled to produce the "achievement score."

The investigators introduced variations in the students' set or "mental condition" before showing the pictures, to see whether resulting variations in the achievement motive would appear. Giving the subjects preliminary exercises on puzzles and other simple tests, the administrator might proceed in an utterly casual and indifferent manner, or in a purposive urgent way he might mention intelligence and leadership qualities as being tested. Or again, by presenting carefully selected low or high norms by which their own test results were to be compared, he might encourage their feelings of success or of failure. Then were presented the pictures for the test of achievement motivation. The authors obtained achievement scores which did vary differentially with differences in the preconditions. The detailed findings have no room here. Suffice it to say that the authors seem to have made good their case for the "achievement-motive" as an identifiable human motive that can be measured in its intensity.

JOHN F. DASHIELL

Department of Psychology
The University of North Carolina

Communication and Persuasion. Carl I. Hovland, Irving L. Janis, and Harold H. Kelley. New Haven: Yale Univ. Press, 1953. xii + 315 pp. $4.50.

PEOPLE have been talking for tens of thousands of years, and reading and writing in gradually increasing numbers for three or four thousand. Yet only in the last decade has any appreciable attention been paid to making communication other than haphazard, except possibly for courses in public speaking founded on almost no research and some equally commonsense work on propaganda.

The authors have approached persuasion from two main premises: research and motivation. The first needs no comment. The second does require a bit of explanation. To quote: "We assume that acceptance (of a new opinion) is contingent upon incentives, and that in order to change an opinion it is necessary to create a greater incentive for making the new implicit response than for making the old one." Thus, an opinion can be established, or changed, only if the listener or reader can be made to *want* to accept the new thought, or if it is more to his advantage to change than to continue to hold the old opinion.

The book is divided into four main sections: Communicator; Content of the communication; Audience predispositions; and Responses: overt expression of the new opinion, and retention of opinion change.

The type of approach used in experiments in this field will be of interest to readers of *The Scientific Monthly*, because most AAAS members are in fields where reduction to a few or even single variables is more attainable than it is in social psychology. Where the situation is one person attempting to persuade another, experiments are more difficult to conceive and control and results must be quoted as trends or probabilities rather than certainties. An interesting example was a measure of audience judgment of fairness and justification of the supposed authors' opinions, with identical statements presented to one group attributed to a "high credibility" source such as a medical journal and to a second group purportedly by such a low source as a movie gossip columnist.

What to me is a conspicuous omission is no reference at all to the many studies on readability. Not a single mention is made of Flesch or others who have worked in this area of communication. Perhaps I am giving this greater importance than it deserves, for two personal reasons: it is the field under the heading of communication with which I was most familiar before reading the present book, and while engaged in industry I was vitally concerned with preparation of manuals which had to be interesting to and understandable for employees with an average of six grades of education. The authors must have decided against including this topic in keeping with their purpose of analyzing technics of persuasion, and chosen not to include such measures as average length of word and length of sentence. But it seems hardly possible that a whole volume could have failed to make one single reference to this well-worked-on research area. Apart from this omission, it is my opinion that Hovland, Janis, and Kelley have done a fine job of organizing, summarizing, and evaluating a new field.

RICHARD W. HUSBAND

Department of Psychology
Florida State University

Psychologie. Grundlagen, Ergebnisse und Probleme der Forschung. Georg Anschütz. Hamburg, Germany: Richard Meiner, 1953. xv + 587 pp. DM 42.

THIS is an encyclopedic work belonging to that almost extinct species of classic *Handbuecher*. Comprising about 3000 references and a list of authors (with indication of birth and death data) filling 28 closely printed pages, Anschütz's treatise gives a monumental inventory of the achievements of European psychology, and does not neglect the results of American psychological science. So far as I am able to ascertain, no field of general or special psychology remains uncovered. Whether one seeks for information on methods in psychology, gestalt psychology, color vision, emotions,

memory, reflexes, freedom of will, mescaline, constitution, eidetics, schizophrenia, parapsychology, or any other topic, one will not be disappointed in finding data on the work done, the authors concerned, and the problems involved. It appears that this enormous material is well organized and presented with absolute objectivity. In any such one-man show, covering the whole of a vast scientific realm, sins of omission and commission can be detected, and the American reader will miss some names or will find the emphasis placed in a way different from that which he is accustomed to or would prefer. He will, however, be more than compensated by the wealth of information on Continental authors, whose work is scarcely accessible or it would take a lifetime to find out. As an indispensable reference work, the book will find its well-deserved place on the shelf of the psychologist and the worker in related fields.

L. von Bertalanffy
Department of Biology, Faculty of Medicine
University of Ottawa, Canada

Readings in the Philosophy of Science. Herbert Feigl and May Brodbeck, Eds. New York: Appleton-Century-Crofts, 1953. ix + 811 pp. $6.00.

FROM the Preface, I note that "An adequate textbook in the Philosophy of the Sciences is badly needed but could hardly be written by a single scholar. The subject is vast, difficult, and undergoing rapid development. We have attempted to assemble some valuable material which, in the hands of able teachers and students, could serve as at least a 'first approximation' to a good and up-to-date text." I believe the editors have very ably accomplished what they have attempted to do. It will, indeed, take an able teacher to guide the young scientist through the selections in the *Readings in the Philosophy of Science*, for they are not easy reading. This is through no fault of the editors, for the subject is a difficult one and it is made especially so because this field is likely to be burdened by the ponderous language and complex form that characterizes most professional philosophy. Some selections seemed to me to be especially clearly written, even sparkling. For example, as a biologist, I found the discussion of teleological explanation by Nagel and that on the philosophy of organic life by Schlick to be vigorous treatments of a subject which is usually badly handled. I found it very boring to read a few of the essays; perhaps other readers, less bound to reality, would find these passages interesting. None of the book is so difficult that the student will be seriously handicapped by a lack of background in philosophy although I recommend that students prepare themselves by attaining the level of sophistication equivalent to mastery of a semester course in philosophy. The mathematical treatment and symbolism in a few of the selections does not (with but one exception) handicap a student who remembers something of his high school algebra.

The *Readings* are organized into eight sections: I, The Nature of the Scientific Method, selections by Pap, Bridgman, Carnap, Reichenback, and Bermann and Spence; II, Philosophy of the Formal Sciences, selections by Carnap, Cohen and Nagel, and Hempel; III, Space, Time, and Relativity, selections by Mach, Poincare, Schlick, Einstein, Reichenback, and Rank; IV, The Logic of Scientific Explanation and Theory Construction, selections by Duhen, Einstein, Bergmann, Campbell, Carnap, Hempel and Oppenheim, Kneale, Beck, and Feigl; V, Causality, Determinism, Indeterminism, and Probability, selections by Russell, Feigl, Nagel, Carnap, Reichenback and Bergmann; VI, Philosophical Problems of Biology and Psychology, selections by Schlick, Nagel, Madden, Spence, Skinner, MacCorquodale and Meihl, Feigl, Bergmann and Meehl; VII, Philosophy of the Social Sciences, selections by Cohen, Passmore, Abel, Nagel, Hook, Zilsel, Watkins, and Lange; VIII, Epilogue, selections by Wigner, Grunnbaum, and Einstein. There is a classified bibliography of about five hundred titles; there is a name index and a subject index.

In my opinion the book will be extremely useful to serious students of the philosophy of science. It will be interesting to some Ph.D. candidates in science, but a condensation and simplification is still needed for the average science student and for all but the exceptional course in the philosophy of science.

Ralph Buchsbaum
Department of Biological Sciences
The University of Pittsburgh

Standard Methods of Clinical Chemistry, Vol. I. Miriam Reimer, Ed. New York: Academic Press, 1953. xii + 142 pp., $3.50.

CLINICAL chemistry is a specialized branch of chemistry, comparatively young and somewhat loosely defined. It comprises segments of biological and analytical chemistry and of human pathology, particularly hematology. Its objective is to provide the medical diagnostician with chemical and quasi-chemical data on the composition of the tissues and excretory products of his patients. Partly on the basis of such data the physician determines the nature of the disease and the degree of its intrusion, and decides upon the therapeutic measures to be insituted. During therapy, clinical chemical data are of continuing importance, and play a monitoring role.

This book is the first volume of a series designed to instruct chemists and technicians working in clinical laboratories in the details of the specific laboratory operations that they are called upon to perform. Methods for nineteen determinations important in blood chemistry are described: amylase; bilirubin; calcium; carbon dioxide (titrimetric); carbon dioxide (Van Slyke); chloride; cholesterol; creatinine; glucose (Folin-Wu); glucose (Nelson-Somogyi); lipase; phosphatase; phosphate; total protein, albumin, and globulin; prothrombin time; sodium and potassium (flame photometry); thymol turbidity; urea nitrogen; and uric acid.

An introduction gives essential instructions for the

collection and handling of blood samples, and for the use of modern photometers. Each method includes a brief discussion of the pertinent chemical principles as well as the biochemical significance of the test, an indication of the normal range of the quantity measured in the healthy human and of the clinical significance of deviations therefrom. Each method in this volume was originally suggested to the editor by a member of the American Association of Clinical Chemists, and, before final acceptance, was checked in the laboratory of at least one other member. In general, the methods do not purport to be new or original, at least in principle, but are based upon procedures previously published.

This compilation seems adequate for the purpose intended: to provide clinical chemists with a practical laboratory guide. It will not of course take the place of fundamental texts in analytical chemistry and biochemistry. To me, an analytical chemist, one criticism seems warranted: there is no systematic specification of the purity of the reagents prescribed. Much effort has been expended by the American Chemical Society Committee on Analytical Reagents, and by the compilers of the *United States Pharmacopoeia* and the *National Formulary*, in specifying impurity limits for most important reagents, including a large proportion of these in the book under review. These U.S.P. and N.F. reagents are legally required to be used in the control testing of drugs for purity. It is surprising that the editor of this volume has not taken advantage of these standards in the equally important clinical chemistry field where a substandard reagent might produce incorrect results and lead to a false diagnosis. It is not sufficient to specify that a reagent shall be "C.P." (Chemically Pure), a term that never had any real meaning and which is rapidly becoming obsolete.

BEVERLY L. CLARKE

Chemical Control Division
Merck & Co., Inc.

Plane Trigonometry. Paul R. Rider. New York: Macmillan, 1953. viii + 180 pp. Illus. $3.00.

THIS compact and nicely printed little volume was prepared by using appropriate chapters selected from the same author's *First-Year Mathematics for Colleges*. The preface states that the book is intended "to provide a complete and thorough course in plane trigonometry for students in colleges and schools of engineering." Other statements in the preface indicate, however, that the author is particularly concerned with the needs of poorly prepared students who will, by solving triangles, develop "not merely confidence but the courage to continue." Such students may think well of this text and for them it has some attractive features.

Illustrative examples are worked out rather carefully, with attention paid to the organization of computational work, and a large number of problems are given (with the usual answers to odd-numbered ones). There is a discussion of significant figures in what the author calls "approximate numbers." Nineteen pages are devoted to logarithms, with the emphasis on the base ten and on computation. The ambiguous case in the solution of triangles is explained in some detail and the principal values of the inverse functions are shown on graphs.

For a competent student, however, the book has such grave defects that it is quite unsatisfactory as a foundation for even a first course in the calculus. Definitions are frequently relegated to subordinate clauses, if they are given at all, and it is not until Chapter 10 that radian (or any other) measure of an angle is discussed. The treatment of a general angle in Chapter 6 does not serve as a satisfactory foundation for the introduction of polar coordinates which, in fact, are not mentioned explicitly. Perhaps the most serious defect of the book is the absence of any emphasis on the trigonometric functions as establishing *functional* relationships between numbers. Indeed, when the sine and cosine curves are finally drawn in Chapter 10, the plates (page 129) have been interchanged and the curves are wrongly labeled! There are many places where a mathematician sensitive to precision of language will wince. For example, the speed of a point on the circumference of a wheel is called (page 118) its linear velocity.

Despite the author's reputation as a writer of well-organized textbooks, one is regretfully forced to conclude that this book does not raise the already low level of excellence of the many trigonometries now in print.

WALLACE GIVENS

New York City

Elementary Quantitative Analysis. Ralph L. Van Peursem and Homer C. Imes. New York: McGraw-Hill, 1953. xiii + 383 pp. $4.50.

THIS textbook is designed for use in a one-year course in elementary quantitative analysis. The organization of this book is unusual in that it is divided into four sections, namely, Principles, Calculations, Experiments, and Laboratory Techniques. In order to keep repetition in the experimental section minimal, there are a considerable number of footnotes and many cross references in this section.

The Principles section is rather elementary and covers the material in a classical manner. Little attention is paid to newer developments in the field of analytical chemistry. The organization of the subject matter in this section is good, with the possible exception of one chapter where separation or isolation, standard solutions, standardizations, indicators, instrumental methods of analysis, and the fundamental theory of colorimetric methods are mentioned or discussed.

The second section, forty-one pages on calculations in quantitative analysis, should be particularly useful to students taking their first course in this subject. There are many numerical solutions to problems and each type of problem is followed by a section of questions and problems—half of them with answers.

The experimental section is divided into thirteen units and contains a total of fifty-seven separate ex-

riments. The objective, introduction (essential theory nd chemistry involved), procedure, and method for aking calculations are given for each experiment. here is a wide choice of experiments so that the needs f almost any elementary course can be met by selecting he proper laboratory exercises.

The last section, Laboratory Technique, describes the roper use and care of quantitative equipment and the arious operations used in an analytical laboratory. he location of this section after the experimental part s certainly a debatable point.

The book is written clearly and very few typographi-al errors were noted. It should be useful where a one-ear course in analytical chemistry is the maximum mount of training that the student is expected to have.

CLARK E. BRICKER

rick Chemical Laboratory
epartment of Chemistry
rinceton University

reparation for Medical Education in the Liberal Arts College. Aura E. Severinghaus, Harry J. Carman, and William E. Cadbury. New York: McGraw-Hill, 1953. 400 pp. $4.50.

THIS is a carefully critical report on a subject of increasing importance—the educational oppor-tunities available to an American student before he enters medical school.

Quite obviously the authors believe that the natures and the qualities of the students admitted to medical school, as well as the curriculum and experience they get there, will determine the kind of doctors we shall have soon. Furthermore, they believe that the doctor needs a good general education as well as professional training. The exposition of this conclusion and its nu-merous corollaries derives from a laborious and detailed study of one hundred fifteen liberal arts colleges taken as a sample. The results of this sampling and the dis-cussion of the present state of education in our colleges and universtiies are set forth earnestly and fully with-out fault finding or evasiveness, and in language that is clear and deliberate. The American college receives such thorough attention in point of its relation to sub-sequent professional training that this report would de-serve reading by teachers in other professional schools.

The report is sober, judicious, and kindly—an attitude that probably answers in its patient realism another impression it conveys, namely, that in point of education we Americans treat our infants as though they were grown up and our college students as though they were infants. If, in response to our changing position in the world, we could prepare our surveys of American edu-cation from an international, as well as an interstate point of view, we would see the two facts that make this report desirable and timely: in the field of higher education throughout the world the American Liberal Arts College is the exception not the rule; and the American medical schools in their complete control of admission policies and their limitation of numbers ad-mitted to classes well below the number of applicants are exploring fields not familiar to most medical schools elsewhere in the world.

This report encourages those who think that reflection upon the kinds of students who are exposed to the medi-cal curriculum may be as valuable a consideration as the kind of curriculum to which "the student," that non-existent generic abstraction, is exposed.

ALAN GREGG

Big Sur, California

Scientific American Reader. New York: Simon & Schuster, 1953. xiv + 626 pp. Illus. $6.00.

LET us assume that it is desirable to have informa-tion concerning science—what it is and what it is doing—as widely spread as possible. How can this aim be accomplished, in view of the prevailing attitude among nonscientists that science is too difficult for the average person to understand? Clearly one approach would be an attempt to dispel the fears of science by presenting expositions of the accomplishments and cur-rent efforts of the scientific community in such a way that any intelligent reader can understand them. The *Scientific American Reader* represents an effort in this direction.

When they begin to read this extensive volume, even scientists become laymen, for the range of topics cov-ered is too sweeping for any scientist to claim profes-sional competence in all the fields dealt with in the fifty-seven articles that make up the twelve "Parts" of the *Reader.* The articles are all reprints (with slight modifications in some cases) of material published in the *Scientific American* during the years from 1948 through 1953. Although science journalists contributed some of the articles, most were written by working scientists. All show the marks of an editorial policy which demanded that the finished articles be clear to anyone interested enough to want to understand.

The editors have not tried to present a comprehen-sive review of the status of modern science; they do claim, with no little justification, that the topics cov-ered ". . . are the currently most hopeful lines of in-quiry, the ones that are yielding, or promise soon to yield, significant new understanding of the world we live in and of ourselves as part of that world."

The arrangement of the articles does not follow the traditional subject-matter breakdown, but it may be said that an analysis based on such a classification would show that the fifty-seven "varieties" served up here swing between astrophysics and genetics, psychology and geology, anthropology and virology, neurophysi-ology and nuclear physics. A few sample topics (authors names in parentheses) may serve to indicate the breadth of coverage: "Galaxies in Flight" (George Gamow); "The Structure of the Nucleus" (Maria G. Mayer); "Reactors" (Lawrence R. Hafstad); "The Genetic Basis of Evolution" (Theodosius Dobzhansky); "The Common Cold" (Christopher Howard Andrewes); "The Pituitary" (Choh Hao Li); "Man's Genetic Fu-

ture" (Curt Stern); "A Chess Playing Machine" (Claude Shannon); "What Is Pain?" (W. K. Livingston).

Neither an annual review nor even a monthly review of the progress of science could hope to present a truly up-to-the-minute snapshot of "Science Today." Therefore it is too much to expect that articles written in some cases as much as five years ago could now be accepted as representative of the latest thinking in the areas of science with which they are concerned. Nevertheless, by a judicious use of footnotes, supplemented by a small amount of rewriting, the articles chosen for the *Reader*, as they now appear, are closer to being topical than most readers would expect. Some deletions of material which otherwise would have been repetitious have been made, and there are a number of cross-references from one article to another; these two steps tend to provide a kind of coherence often lacking in such compilations.

Many diagrams and drawings were prepared especially for this volume. Although they are generally adequate, they represent a distinctly inferior level of illustration when compared with that usually found in the *Scienific American*.

The face-lifting and general revitalizing that the *Scientific American* underwent in 1948 was accomplished by a group of science journalists who put into action their conviction that it is possible to bring about a wider and more soundly based understanding of science. The editors have attempted to make their magazine ". . . a medium of communication between scientists and their fellow men," with one of their aims being to combat "Illiteracy in science . . . as it prevails among otherwise educated members of our society."

I feel that the *Scientific American Reader* is a significant contribution toward the end results that its editors, together with many others, are seeking. The collection of articles they have assembled into the *Scientific American Reader* will probably reach a broad audience and should serve to convince many laymen (and some scientists) of the real importance of science in our culture.

BOWEN C. DEES

National Science Foundation
Washington, D. C.

Astrology and Alchemy: Two Fossil Sciences. Mark Graubard. New York: Philosophical Library, 1953. xi + 382 pp. Illus. $5.00.

THIS book is essentially a history of pre-astronomy and pre-chemistry. As such, it may be read profitably whether or not one agrees with the novel contention of the author that astrology and alchemy are "fossil sciences."

The eight chapters on astrology cover its history from its early beginnings up to the times of Tycho, Copernicus, Kepler, Galileo, and Newton. The various geocentric theories are well explained with the aid of some good diagrams. The ups and downs of astrology through the centuries are carefully followed. Tycho, Kepler, and Galileo are to be numbered among the defenders of astrology, even though they helped to bring about its demise. And when Newton entered the University of Cambridge in 1660 and was asked what he wished to study, replied, "Mathematics, because I wish to test judicial astrology." The Copernican revolution is the beginning of the modern science of astronomy and the end of astrology. "The modern practitioners [of astrology] have nothing in common with the logic of Ptolemy or Kepler, but the mental labors of the latter and the many other believers in the astrological hypotheses of the past were true soldiers in man's struggle for scientific truth."

The four chapters on alchemy cover its history from the Egyptians and Greeks to the time of Lavoisier. "The roll call of alchemists comprises every famous name of the Middle Ages. From Roger Bacon . . . to Pope John XXII, the alchemist, who issued two Bulls against false pretenders in the field, presumably to rid it of unworthy amateurs more interested in gain than truth." Bernard of Treviso, who died the year before Columbus discovered the New World, studied alchemy from the age of fourteen to the day of his death at eighty-five. At one time he settled down in France for eight years to study the chemical properties of eggs, and boiled two thousand eggs, separated shells, whites, and yokes, and studied the composition of each. Another alchemist, Bötticher perfected the first Dresden china. Such work was, of course, merely incidental to the great search for transmutation. Finally, by the time of Paracelsus the outlook had changed to "the object of chemistry is not to make gold but to prepare medicines." And gradually, through the work of Boyle, Priestley, Cavendish, Lavoisier, and many others, chemistry was turned in the direction of its modern development.

Professor Graubard's book is interesting as history, and worth reading as history. But it is difficult to accept the "fossil science" idea. Magic and the supernatural are not a part of modern science, and they were a part astrology and alchemy. The "best minds" of the past were not necessarily "scientific minds." Their beliefs were not necessarily "science."

FRANK K. EDMONDSON

Goethe Link Observatory
Indiana University

The Journals of Lewis and Clark. Bernard De Voto, Ed. Boston: Houghton Mifflin, 1953. lii + 504 pp. $6.50.

CAPTAINS Meriwether Lewis and William Clark set out from St. Louis on May 14, 1804, to proceed up the Missouri River to its source. Their journey, which consumed more than two years, led them to the headwaters of the great Missouri in what is today Montana, across the continental divide, down the Columbia to its mouth, and back again to make one of the most important odysseys of American history, and certainly one of the best-documented.

Their journals contain rich and varied information

In a message to Congress on January 18, 1803, President Jefferson merely indicated that an expedition was to be made "for the purpose of extending the external commerce of the United States." Actually it was intended as the first move toward breaking the British monopoly of the lucrative fur trade of the Canadian West. Militarily, the expedition was in the nature of a reconnaissance. Ostensibly, however, the journey was a scientific venture and was so explained to the ministers of Spain, France, and Great Britain. Jefferson's instructions to Lewis set forth very clear objectives: "The object of your mission is to explore the Missouri River (to search for) the most direct and practicable water communication across this continent for the purposes of commerce." Perhaps more significantly he added, "The commerce which may be carried on with the people inhabiting the line you will pursue renders a knowledge of these people important. . . . Other object (sic) worthy of notice will be the soil and face of the country, its growth and vegetable productions . . . the animals of the country generally . . . the mineral productions of every kind. . . ." The observations on matters such as these give the journals much of their quaint and piquant flavor.

Written concurrently by Lewis, the educated and speculative leader whose prose is vividly descriptive and often lyrical, and by the intelligent but uneducated Clark whose style is graphic and whose ingenuity in phonetic spelling is exceptional, the journals cannot fail to charm the anthropologist, the naturalist, the historian, or the casual reader seeking a good adventure story. Lewis' account of the first contacts of his party with the Shoshone Indians, for example, is a skillful and even dramatic piece of writing. And who can deny the effectiveness of a single entry such as the following, recorded by Clark on July 21, 1805, somewhere south of Great Falls, Montana: "a fine morning our feet So brused that I deturmined to delay for the Canoes, & if possible kill Some meet by the time the arrived, Small birds are plenty. Some Deer Elk, Goats, and Ibex; no buffalow in the Mountains. Those mountains are high and a great perportion of them rocky: Vallies firtile I observe on the highest pinecals of some of the Mountains to the West Snow lying in Spots Some Still Further North are covered with Snow. . . ."

Bernard De Voto now brings these accounts to the general reader in a much condensed form. In 1904 the complete journals appeared under the editorship of Reuben Gold Thwaites in an edition which ran to eight volumes. De Voto now makes the journals available in a single medium-sized volume. Fascinated for many years with the adventure and romance, as well as with the cultural significance of America's westward movement, he has been especially intrigued with the problems that faced Lewis and Clark, and has personally retraced much of their route. He assumes that the reader with a specialist's interest will not find the present volume adequate to his needs. In his splendid preface we read, "Anyone who wants all the data, full information, or assurance that on any given point he has read everything the captains wrote must go to the original." For its purpose, it is an excellent book.

E. Ashby Hammond

Department of History
University of Florida

Books Reviewed in SCIENCE

March 26

Progress in Organic Chemistry, Vol. II, J. W. Cook, Ed. (Academic Press; Butterworths). Reviewed by A. H. Blatt.

Les Proteines, Neuvieme Conseil de Chimie, l'Universite de Bruxelles (R. Stoops). Reviewed by Mark H. Adams.

April 9

The World of Primitive Man, Paul Radin (Henry Schuman). Reviewed by A. Irving Hallowell.

Structure and Mechanism in Organc Chemistry, C. K. Ingold (Cornell Univ. Press). Reviewed by G. W. Wheland.

Applied Electron Microscopy, Robert B. Fischer (Indiana Univ. Press). Reviewed by A. Glenn Richards.

Introduction to Electron Microscopy, Cecil E. Hall (McGraw-Hill). Reviewed by A. Glenn Richards.

Biochemical Preparations, Vol. 3, Esmond E. Snell, Ed. (Wiley; Chapman & Hall). Reviewed by Albert A. Dietz.

April 23

Recurrent Maladies in Scholarly Writing, Eugene S. McCartney (Univ. of Michigan Press). Reviewed by Phelps Soule.

The Language of Science, Theodore H. Savory (Andre Deutsch). Reviewed by Donald J. Lovell.

The Hand-Produced Book, David Diringer (Philosophical Library). Reviewed by Louis B. Wright.

Ideologie und Forschung in der Sowjetischen Naturwissenschaft, Schriftenreihe Osteuropa, No. 1, Arnold Buchholz (Deutsche Verlags). Reviewed by Theodosius Dobzhansky.

Climatic Change: Evidence, Causes, and Effects, Harlow Shapley, Ed. (Harvard Univ. Press). Reviewed by Dean B. McLaughlin.

Dialogue on the Great World Systems, Galileo Galilei, revised and annotated by Giorgio de Santillana (Univ. of Chicago Press; Cambridge Univ. Press). Reviewed by Thomas S. Kuhn.

Dialogue Concerning the Two Chief World Systems—Ptolemaic & Copernican, Galileo Galilei, trans. by Stillman Drake, foreword by Albert Einstein (Univ. of California Press). Reviewed by Thomas S. Kuhn.

Principles of Numerical Analysis, Alston S. Householder, (McGraw-Hill). Reviewed by E. C. Nelson.

Astronomical Photoelectric Photometry, Frank Bradshaw Wood, Ed. (AAAS). Reviewed by Gerald E. Kron.

The Sun. The Solar System, Vol. I, Gerard P. Kuiper, Ed. (Univ. of Chicago Press). Reviewed by R. Grant Athay and Walter Orr Roberts.

The Elements of Mathematical Analysis, Vols. I and II, J. H. Michell and M. H. Belz (Macmillan, ed. 2). Reviewed by Frederic H. Miller.

Scientific Papers Presented to Max Born, Sir Edward Appleton *et al.* (Hafner). Reviewed by P. Morrison.

Thunderstorm Electricity, Horace R. Byers, Ed. (Univ. of Chicago Press). Reviewed by W. D. Parkinson.

Dislocations and Plastic Flow in Crystals, A. H. Cottrell (Oxford Univ. Press). Reviewed by James S. Koehler.

Dislocations in Crystals, W. T. Read, Jr. (McGraw-Hill). Reviewed by James S. Koehler.

Radioactive Isotopes, W. J. Whitehouse and J. L. Putnam (Oxford Univ. Press). Reviewed by Martin D. Kamen.

Principles of Transistor Circuits, Richard F. Shea, Ed. (Wiley; Chapman & Hall). Reviewed by Alan B. Macnee.

Present Problems in Nutrition Research, F. Verzár, Ed. (Verlag Birkhauser). Reviewed by Jean Mayer.

A Simple Guide to Modern Valency Theory, G. I. Brown (Longsmans, Green). Reviewed by L. H. Farinholt.

Chemistry of the Lanthanons, R. C. Vickery (Academic Press; Butterworths). Reviewed by Don M. Yost.

The Proteins, Vol. I, Parts A and B. Hans Neurath and Kenneth Bailey, Eds. (Academic Press). Reviewed by John I. White.

Synthetic Methods of Organic Chemistry: An Annual Survey, Vol. 6, W. Theilheimer (S. Kargar; Interscience). Reviewed by Henry Feuer.

Principles of Polymer Chemistry, Paul J. Flory (Cornell Univ. Press). Reviewed by Frederic T. Wall.

The Screen Projection of Chemical Experiments, E. J. Hartung (Melbourne Univ. Press; Cambridge Univ. Press). Reviewed by Hubert N. Alyea.

Plant Growth Substances, L. J. Audus (Leonard Hill; Interscience). Reviewed by James Bonner.

Catalogue of Fossil Cirripedia in the Department of Geology (British Museum), Vol. III: *Tertiary,* Thomas Henry Withers (British Museum). Reviewed by Dora Priaulx Henry.

Primates: Comparative Anatomy and Taxonomy, Vol. I: *Strepsirhini,* W. C. Osman Hill (Edinburgh Univ. Press; Interscience). Reviewed by Bryan Patterson.

The Polyporaceae of the United States, Alaska and Canada, Lee Oras Overholts; prepared for publication by Josiah L. Lowe (Univ. of Michigan Press; Oxford Univ. Press). Reviewed by L. R. Hesler.

Phylogeny and Morphogenesis: Contemporary Aspects of Botanical Science, C. W. Wardlaw (Macmillan; St Martin's Press). Reviewed by Ralph H. Wetmore.

Physiological Acoustics, Ernest Glen Wever and Merle Lawrence (Princeton Univ. Press). Reviewed by Robert Galambos.

Nerve Impulse, David Nachmansohn, Ed. (Josiah Macy, Jr. Fdn. (Reviewed by L. J. Mullins.

Textbook of Genetics, William Hovanitz (Elsevier). Reviewed by Ernst Caspari.

The Anatomy of the Migratory Locust, F. O. Albrecht (Althone Press; Curtis Brown). Reviewed by Ashley B. Gurney.

General Virology, S. E. Luria (Wiley; Chapman & Hall). Reviewed by R. Dulbecco.

The Medusae of the British Isles: Anthomedusae, Leptomedusae, Limnomedusae, Trachymedusae, and *Narcomedusae,* Frederick Stratten Russell (Cambridge Univ. Press). Reviewed by Joel W. Hedgpeth.

Adventures in Physiology: A Selection of Scientific Papers, Henry Hallett Dale (Pergamon Press; Macmillan). Reviewed by A. McGehee Harvey.

The Conquest of Plague. A Study of the Evolution of Epidemiology, L. Fabian Hirst (Oxford Univ. Press). Reviewed by Ernest Carroll Faust.

Problems in the Anatomy of the Pelvis: An Atlas, Eduard Uhlenhuth, with assistance of DeWitt T. Hunter; illus. by William E. Loeche (Lippincott). Reviewed by Barry J. Anson.

Symposium on Fatigue, W. F. Floyd and A. T. Welford, Eds. (H. K. Lewis). Reviewed by S. Howard Bartley.

The Physiopathology of Cancer, Freddy Homburger and William H. Fishman, Eds. (Hoeber-Harper). Reviewed by W. E. Heston.

Frontal Lobes and Schizophrenia, Milton Greenblatt and Harry C. Solomon, Eds. (Springer). Reviewed by Jerzy E. Rose.

April 30

The Nature and Significance of the Antibody Response, A. M. Pappenheimer, Jr., Ed. (Columbia Univ. Press). Reviewed by Dan H. Campbell.

Sexual Behavior in the Human Female, Alfred C. Kinsey *et al.* (Saunders). Reviewed by Bentley Glass.

Glycols, American Chemical Society Monograph 114, George O. Curme, Jr., Ed., and Franklin Johnston, Assoc. Ed. (Reinhold). Reviewed by Henry Feuer.

The Determination of Adrenocortical Steroids and Their Metabolites, P. Eckstein and S. Zuckerman, Eds. (Dennis Dobson). Reviewed by Kenneth Savard.

The Physics of the Stratosphere, R. M. Goody (Cambridge Univ. Press). Reviewed by Homer E. Newell, Jr.

There is nothing more likely to betray a man into absurdity than condescension—when he seems to suppose his understanding too powerful for his company.—Samuel Johnson.

LETTERS

Animistic Thinking

THE day after the arrival of the January 1954 issue of *The Scientific Monthly* with the letter from Professor Crannell on his questionnaire on animistic thinking, (page 54), I came across the following on page 150 of the Transactions of the Sixth Conference on Cybernetics of the Josiah Macy, Jr. Foundation (1949):

McCulloch: "I would like to pick up the ball and start it rolling if I may. In the first place I would like out of my prejudices to answer Larry Kubie a bit. I am a Scot. I think like most all Scots, I fall in love with machines and particular machines. I am a sailor. I know that almost every sailor falls in love with a ship and it becomes as unique as a person identified in the same manner as our fellow man identifies us. I don't think any greater difficulty rests in the fact that the other machine is a man instead of being made out of wheels or out of canvass."

Kubie: "It is only a degree."

McCulloch: "It is not a fundamental difficulty."

Stroud: A machine in my laboratory has a personal label."

Mead: "But the ship does not fall in love with you."

McCulloch: "I am not so sure."

TEMPLE BURLING

New York State School of Industrial and Labor Relations Ithaca, New York

Attracting Students to Science Careers

I have read with considerable interest the paper by R. H. Johnsen in the January issue. The idea of exposing high-school students to the atmosphere of work which they may later carry out is excellent and certainly superior to the so-called "career days" sometimes held in high schools. However, to give young people an objective comparison, it is desirable that attempts similar to those described by the author be made in other fields of human activity. Only the possibility of making an objective comparison will give the student a sound basis for a choice. We still will not get away from the difficulty that, if the adult whom he observes in the one field is very inspiring and another adult in a different field is very dull, the student will get a biased picture of the field.

Regarding the lack of scientists and of young people selecting a science career, Johnsen speculates about the possibility that the destructive work of scientists in connection with weapons development may be repugnant to young people. If the author is right, this would be an encouraging sign indeed. Work on such projects is, for several reasons, contrary to the true spirit of science.

If we would start to present young scientists not only with knowledge in their field but with the broader implications of science for human society, the field of science might become more attractive to the most promising young people. May I refer, in such connection, to the excellent paper by F. C. Neff in the same issue. To prove this point, I refer to only two quotations of many that are relevant. If one accepts the statements made there, one cannot reasonably agree to work on weapons development.

"Our present predicament is due more than anything else to the fact that we have learned to understand and control to a terrifying extent the forces of nature outside us, but not those that are embodied in ourselves." [B. Russell, quoted on p. 20]

"[The first moral principle of science] is that all judgments are in the public world, in the open, where men's minds can try to agree, not in the arcanum of any single personal experience where any man can believe what he pleases. . . ." [L. Bryson, quoted on p. 26]

VICTOR PASCHKIS

School of Engineering Columbia University, New York

Consumers and the National Bureau of Standards

IN his interesting and informative article on "The National Bureau of Standards" [*Sci. Monthly* **77**, 295 (1953)], Nate Haseltine says "Bureau scientists . . . were irritated by the public's reaction in besieging them for advice as to which products—be they floor wax, soap, or auto batteries—are the best on the market." This irritation may be caused by the fact that the scientists think that by this time the work of the Bureau should be well enough known to preclude the reaction mentioned. On the other hand, in the 17 years I was at the National Bureau of Standards I heard of many requests from consumers of the kind Mr. Haseltine cites; and what irritation I observed among the scientists was caused not so much by the public's misconception of the Bureau's function as by the proscription against giving the consumers the information they sought.

WILLIAM R. OSGOOD

Department of Mechanics Illinois Institute of Technology

Logic or Beauty?

Professor Dirac, in his article, "Quantum mechanics and the aether," [*Sci. Monthly* **78,** 144 (1954)] states that the beauty of the theory underlying the principle of indeterminacy was the factor that has caused it to be accepted by physicists.

The beauty of the theory had absolutely nothing to do with the acceptance of the theory by the physicists.

In the next paragraph, Dirac contradicts himself: "*All* that a physicist really wants of his theory is a definite set of rules enabling him to obtain results that can be compared with experiment. . . ." (Italics mine). This is correct, in my opinion.

ARMAND LOWINGER

113 Columbia Heights Brooklyn, New York

ASSOCIATION AFFAIRS

PRELIMINARY ANNOUNCEMENT OF THE BERKELEY, CALIFORNIA, MEETING, DEC. 26–31, 1954

THE 121st Meeting of the American Association for the Advancement of Science, the annual meeting for the year 1954, will be unique in several respects. It will be the first national *winter* meeting of the AAAS west of the Rockies. Second, it will be the first time in recent years that the December meeting has been concentrated on one campus. Third, for the last week of the year, Berkeley will be the statistical capital of the world. However, all principal fields of science will be represented. The number and variety of participating organizations indicate that this year's national AAAS meeting will be by far the largest diversified scientific meeting ever held on the Pacific Coast.

Consistent with the westward shift of the nation's population and increasing AAAS membership, the Association's meetings in the West have increased—though, at first, only gradually. The fifth meeting of the Association in 1851 in Cincinnati was the first meeting held west of the Appalachians. In 1872, the 21st meeting, in Dubuque, Iowa, reached the Mississippi. In 1901, the Association's 50th meeting was held in Denver, in the shadow of the Continental Divide, and then 14 years later the shore line of the Pacific at last was reached.

The 67th or "First Pacific Coast Meeting" of the AAAS, Aug. 2–7, 1915, was held with the double purpose of aiding in the development of science in that region and celebrating the completion of the Panama Canal. Some sessions were held in Berkeley, on the campus of the University of California, and some in San Francisco, downtown and on the grounds of the Panama-Pacific International Exposition next to the Presidio. A full day was scheduled at Stanford University. The Pacific Division of the Association had been organized, but it counts as its first meeting the one in San Diego Aug. 1916. With the exception of the war years 1917, and 1943–45 inclusive, the AAAS Pacific Division has met each year throughout its territory.

With the First Pacific Coast Meeting a success, it is not surprising that thereafter the national AAAS, whenever possible, met summers with the Pacific Division: in 1922, at Salt Lake City; in 1923, at Los Angeles; in 1925, at Portland, Ore.; in 1931, at Pasadena; in 1934, at Berkeley; and in 1940, at Seattle. This year's national meeting of the Association, however, is the Association's first large-scale, or winter, meeting on the "Pacific Rim."

Usually, at a typical AAAS meeting, some sessions are held in academic buildings of universities in the convention city; but for many years it has been impossible to center the entire meeting at one institution. At Berkeley, however, the exceptional facilities of the compact campus of the University of California make possible a unified and convenient meeting. As host, the University of California has most generously offered every necessary facility: well-equipped session rooms in its newest classroom buildings; its cafeterias nearby; all dormitory units—with breakfasts served "in" if desired—and, quite without precedent, the large Gymnasium for Men which will house the Registration Center, the AAAS Science Theatre, and the Annual Exposition of Science and Industry. With some lounge facilities installed, this building, on Dana Street, will serve as the center of the meeting.

In addition to the meetings of the American Statistical Association, the Institute of Mathematical Statistics, and the Biometric Society, WNAR, the Third Berkeley Symposium on Mathematical Statistics and Probability will bring together the leading statisticians of all continents and, thus, lend a welcome international quality to the 121st Meeting. This Symposium, or Congress, held at intervals of 4 or 5 years, will have sections for both pure statistics and applications to astronomy, biology, public health, and other fields.

When the Board of Directors of the Association selected the Pacific Coast as a meeting place, the vote was unanimous and upon condition it would not interrupt the regular June meetings of the AAAS Pacific Division. It was further agreed that the administrative office of the Division would not be called upon to lend assistance beyond advice, information, and good wishes. Accordingly, the Pacific Division scheduled its 1954 and 1955 meetings in Pullman, Wash., and Pasadena, Calif.

Although the December AAAS meeting in Berkeley will not be a joint meeting with the Pacific Division, the Division will, in a sense, be host to the national organization. The Division's constituent societies—and its individual members—will enjoy playing hosts to their colleagues from other parts of the country.

Virtually all the societies that meet regularly with the Pacific Division will also have sessions for contributed papers, special programs, or both, at Berkeley. Societies that will hold their national meetings with the AAAS at Berkeley include the American Society of Limnology and Oceanography, the Society of Systematic Zoology, the National Association of Biology Teachers, the American Nature Study Society, the Meteoritical Society, and the seismologists. Other national societies arranging special programs include the American Society of Naturalists, Ecological Society of America, and the Mycological Society of America. Among the regional organizations, the annual December Pacific Coast meeting of the American Physical Society, the regular winter meeting of the Western Society of Naturalists, the Western Psychological Association, the Astronomical Society of the Pacific, the California State Veterinary Medical Association, the Southern

California and Northern California-Hawaiian Branches of the Society of American Bacteriologists, the Southern California and Pacific Coast Sections of the Society of Experimental Biology and Medicine, *et al.*, all will augment the attendance and make this a record-breaking scientific conclave.

Transportation. A trip to California is a memorable experience at any time and, in this modern period, the approach of winter need change no one's wish to reach Berkeley. In general, there is no reason to be uneasy about cancellation or serious interruption of scheduled transcontinental air and railroad service. Automobile transportation is feasible. The all-weather southern route via Arizona and the Great Valley permits a side trip to Grand Canyon.

Beginning with the May issue of *The Scientific Monthly*, a page in the advertising section outlines the one-way travel time between New York, Washington, Chicago, and San Francisco. Also given are the round-trip fares, with the new lowered 10 percent federal transportation tax included.

Housing. Sleeping accommodations are unlimited but, of course, vary in their convenience to the campus. Those in Berkeley alone can accommodate 2500 persons, since all the dormitories, a block of rooms at International House, and all hotels and motels are committed. In reserve are the housing facilities of the neighboring community of Oakland and of San Francisco, across the great Bay Bridge. All housing will be handled by the AAAS Housing Bureau, which will be operated by the Berkeley Convention Bureau.

The dormitories of the University, accommodating about 750 persons, will be available at a uniform rate of $2 per person the *first night* and $1 per night thereafter. Priority for these will be given to students and younger scientists. In the hotels, single rooms range from $4 to $10 per night at the Shattuck and Durant, for example; $5 to $11 at the Claremont; all have rooms without bath at $3 per night. All motels charge $4 to $5 per night per single room; $5.50 to $8 for twin-bed rooms. The motels not close to the campus will be assigned to those who drive to the meeting. Headquarters of each participating society will be given in a later announcement. Detailed housing information and a coupon for room reservations will appear in *Science* and *The Scientific Monthly* beginning in July.

Advance registration. As in recent years, advance registrants will receive the General Program-Directory early in December by first-class mail. Coupons will appear in the AAAS journals beginning in late July.

Tours. A committee on tours has not been appointed but it is anticipated that there will be a demand for tours to the following: (i) Strawberry Canyon, the Berkeley Hills, Mount Diablo; (ii) California Academy of Sciences in Golden Gate Park—Museum, Aquarium, new Planetarium; (iii) Mount Tamalpais and Muir Woods (redwoods); (iv) Stanford University and Mount Hamilton.

AAAS general symposium. By custom, the President of the Association is chairman of the Symposium Committee and, with the approval of the Board of Directors, he appoints the remaining members. The 1954 Symposium Committee consists of Warren Weaver, Rockefeller Foundation, *chairman*; George W. Beadle, California Institute of Technology; Fred N. Briggs, University of California, Davis; Perry Byerly, Adriance S. Foster, Joel H. Hildebrand, Ernest O. Lawrence, Jerzy Neyman, Robert G. Sproul, Wendell M. Stanley, and Otto Struve, all of the University of California, Berkeley; Joseph Kaplan, Louis B. Slichter, and Stafford L. Warren, of the University of California, Los Angeles; Harry J. Deuel, Jr., University of Southern California; Donald H. McLaughlin, Homestake Mining Company, San Francisco; Robert C. Miller, California Academy of Sciences; Roger R. Revelle, Scripps Institution of Oceanography; Robert R. Sears and Douglas M. Whitaker, of Stanford University; Raymond L. Taylor, AAAS, *secretary*.

The Committee met at Berkeley on Feb. 25 and decided on one general symposium, "Science and society," the three sessions of which will be held on three consecutive afternoons beginning at 4 P.M. The individual sessions were outlined in a preliminary way and were made the responsibility of three program chairmen as follows: I. "Resources," Louis B. Slichter; II. "Population problems," Curt Stern, University of California, Berkeley; III. "Impact of science on society," Roger R. Revelle.

Special sessions. The special sessions that have already been planned are as follows: Dec. 27, annual address of Phi Beta Kappa (15th in the series), 8:30 P.M.; Dec. 28, AAAS Presidential Address by E .U. Condon, 8 P.M., followed by a reception; Dec. 29, Society of the Sigma Xi annual address (annual since 1922), 8:30 P.M.; Dec. 30, Scientific Research Society of America annual address (6th in the series), 8:30 P.M. The Pacific Science Board will sponsor an address, and the National Geographic Society will have its usual excellent lecture and accompanying film.

The Programs

A—Mathematics

Section A and the *American Mathematical Society* will have joint sessions on two days for contributed papers and invited addresses and will cosponsor appropriate programs. The *American Statistical Association* will hold a regional meeting, with Maurice I. Gershenson as program chairman. Among the sessions being arranged are: "Regional indexes of business activity" and "Regional unemployment estimates" with cosponsorship by the *Pacific Coast Committee on Social Statistics* of the Social Science Research Council; the society's Committee on Statistics in the Physical Sciences is developing sessions on "What does probability mean to the engineer, physicist, and mathematician?" and will cosponsor a number of the other statistical sessions. The annual national meeting of the *Institute of Mathematical Statistics* will be held with the AAAS in Berkeley Dec. 26–31, inclusive. Under the direction of Jerzy Neyman, the *Third Berkeley Symposium on Mathematical Statistics and Probability* will have sessions for papers devoted to mathematical statistics proper; applications to mathematics, astronomy, physics, and engineering; applications to genetics and biology; and applications to public health.

B—Physics

Section B will schedule a vice presidential address by George R. Harrison and will cosponsor appropriate programs. The *American Physical Society* will hold its regular December meeting with sessions for contributed papers and for invited addresses. Under the chairmanship of Cornelius A. Tobias, the *Donner Laboratory* of the University of California will arrange a symposium, "Biological structures: Biophysics of growth," cosponsored by the *American Physical Society* and probably by AAAS Sections B and N. The *American Meteorological Society* will hold one of its several annual national meetings with the AAAS, and *Sigma Pi Sigma* will cosponsor the Physicists' Dinner.

C—Chemistry

Section C will have several sessions for contributed papers, symposia, the Chemists' Dinner, and a vice presidential address by Wendell M. Latimer. *Alpha Chi Sigma* will sponsor a luncheon. It is probable that Harry S. Mosher will arrange a program for the California Section of the *American Chemical Society*. The *Pacific Southwest Association of Chemistry Teachers* will have a program.

D—Astronomy

Section D is arranging a vice presidential address by Bart J. Bok, and joint symposia, "Statistics of extragalactic nebulae" and "Statistics of the Hertzsprung-Russell diagram," with the *Statistical Laboratory of the University of California*, together with the cosponsorship of the program of the *Astronomical Society of the Pacific* and joint sessions for contributed papers Dec. 27–29, inclusive. The national meeting of the *Meteoritical Society* will comprise 4 sessions.

E—Geology and Geography

Section E is scheduling several sessions for contributed papers in both geology and geography; a two-session symposium, "Earth sciences from the air"; the Geologists' Smoker; and a vice presidential address by Meredith F. Burrill. The *Geological Society of America* will cosponsor Section E's sessions. The *California State Division of Mines* will conduct tours and display some exhibits. A regional meeting of the *Seismological Society of America* is scheduled. The *National Speleological Society* will hold a regional meeting, and the *Arctic Institute of North America* will cosponsor one of the symposia of the Western Society of Naturalists.

F—Zoological Sciences

Section F plans some sessions for contributed papers in fields of zoology other than systematic zoology, the cosponsorship of appropriate symposia of other societies, a vice presidential address by Horace W. Stunkard, and the cosponsorship of the Zoologists' Dinner. Under the direction of C. V. Duff, the *Cooper Ornithological Society* will have a joint meeting of the Northern and Southern Divisions. The *Herpetologists League*, with Angus M. Woodbury arranging the program, will have a session for contributed papers, a symposium, an informal session for unlisted papers, and a dinner. The *Pacific Coast Entomological Society* will have one or more sessions. The *Society of Systematic Zoology*, with Robert C. Stebbins as program chairman, plans a national meeting, with its Western Division as host, which will include sessions for contributed papers in systematic zoology and evolution, symposia, and the cosponsorship of the Zoologists' Dinner.

FG—Zoological and Botanical Sciences

Among the societies whose fields lie in both botany and zoology, the *American Society of Limnology and Oceanography* will hold its national meeting and have five sessions for contributed papers and a symposium "Recent advances in biological oceanography," organized by R. W. Hiatt. A symposium is scheduled for a special meeting of the *American Society of Naturalists*. The *Biometric Society, WNAR*, will have sessions for contributed papers and joint sessions with the *Institute of Mathematical Statistics*. Russel K. LeBarron and E. C. Stone will be cochairmen of the program of the *Ecological Society of America*, under the sponsorship of its Western Section. The program includes two days of sessions for contributed papers, a symposium, "Is dew an important ecological factor?" an all-day field trip, and a dinner. The *National Association of Biology Teachers* will hold its national meeting with a program on conservation, sessions for contributed papers, panels, a field trip, and other sessions joint with the *American Nature Study Society*. Plans for the regular annual meeting of the *Western Society of Naturalists* are being arranged by John L. Mohr and Richard Eakin for Dec. 27–29. The program consists of symposia on "Conservation of natural resources of the West," arranged by Arthur C. Giese and "The cell," arranged by Daniel Mazia and Roger Stanier; and there will be concurrent sessions for invited and submitted papers on photobiology, parasitology, ecology, histology-embryology, physiology, natural history, teaching problems in biology, and arctic biology. The society will have a banquet for all naturalists.

G—Botanical Sciences

Section G plans cosponsorship of appropriate programs and probably will have sessions for contributed papers not covered by the participating societies of Section G. The vice presidential address will be given by Stanley A. Cain, and the Section will cosponsor the Botanists' Dinner. The Pacific Division of the *American Phytopathological Society* will have, at its special meeting, a conference on control of soil microorganisms associated with plant diseases; a symposium, "Crop sequence and plant disease control"; three concurrent sessions of general and invited papers; and a banquet. The *Mycological Society of America* will have two joint symposia with the phytopathologists: "Physico-chemical control of structural differentiation in the fungi" and "The mode of survival of plant pathogens in the soil"; and sessions for contributed papers. The Western Section of the *American Society of Plant Physiologists* has planned one or more symposia and sessions for contributed papers. The *Botanical Society of America* will probably cosponsor appropriate programs. The *Society of General Physiologists*, with Albert Tyler as program chairman, will have at least a day of contributed papers and will cosponsor the preceding symposium, "The cell."

H—Anthropology

Section H is scheduling sessions for contributed papers in anthropology and archeology, symposia on "Indians of western North America," "Culture change in the Pacific region," and on several other subjects.

I—Psychology

Section I plans sessions for invited papers: one on highway safety research, arranged by T. W. Forbes, others on the central nervous system—Donald B. Lindsley

human factors in equipment design—Arnold Small; and experimental social psychology; sessions for contributed papers; and a vice presidential address by Dr. Lindsley. The *Western Psychological Association* will have three symposia, arranged by Rheem F. Jarrett, and one invited address. The *Society for Research in Child Development*, with Robert R. Sears as program chairman, is planning a day of sessions.

K—Social and Economic Sciences

Organized last year, the Section K program committee, representing nine participating societies and headed by Harold E. Jones, has decided on five symposia to be presented by panels as follows: "Pacific coast population trends," Calvin Schmid, chairman; "The structure of cities," Leonard Broom, chairman; "Regional and interregional economic problems," David Revzan, chairman; "Organization of research on western development," Ernest Engelbert, chairman; and "Cost-benefit analysis," M. L. Upchurch, chairman. The *Western Economic Association* will participate as a cosponsor. The section will have a dinner meeting, Dec. 29, at which vice president J. B. Condliffe will deliver his address entitled "The international consequences of scientific research." The *National Academy of Economics and Political Science* will have a symposium on the Randall Report. The *Committee for Social Physics* will have three sessions, "Diffusion theory," "Human values measurement," and Isomorphisms," arranged by Stuart C. Dodd. The *Society for the Advancement of Criminology* is arranging a program with William Dienstein as chairman.

L—History and Philosophy of Science

Section L plans sessions for contributed papers and symposia and a vice presidential address. The *Philosophy of Science Association* will have several sessions.

M—Engineering

Baldwin M. Woods, program chairman for Section M, reports that no less than eight sessions are being planned as follows: "Prosthetic devices," arranged by Eugene Murphy; "Highway safety—relation of eye defects to accidents"; "Seismology"; "Oceanography (ocean as a source of food)"; "Water, irrigation, and power"; "Stream pollution"; "Present state of the smog problem"; "Highest use of raw materials."

N—Medical Sciences

Alpha Epsilon Delta National Premedical Honor Society will schedule a general session on premedical education, a luncheon, and workshop groups. A symposium is being arranged for the meeting of the *American Academy of Forensic Sciences* by Ralph F. Turner. The *American Association of Hospital Consultants* is scheduling a symposium, as is the *American Psychiatric Association*. The *California State Veterinary Medical Association* is planning sessions for its regular winter meeting. David M. Greenberg is arranging two sessions for contributed papers for the meeting of the *Pacific Slope Biochemical Conference*. The *Society of American Bacteriologists* is scheduling a joint meeting of its Southern California and Northern California-Hawaiian Branches. Paul Starr and Robert H. Dreisbach, program chairmen for the *Society for Experimental Biology and Medicine* at the joint meeting of the Southern California and Pacific Coast Sections, plan one session for papers, another for a symposium, "Adrenal-pituitary relationships." An important three-day international *Conference on Animal Venoms* is being arranged by Nandor Porges and will be cosponsored by Sections F and N.

Subsection Nm—Medicine

Subsection Nm will sponsor a four-session symposium on cancer entitled "Physiology of growth—normal and abnormal," being arranged by Howard R. Bierman. The vice presidential address will be given by Charles B. Huggins and the 1954 Theobald Smith Award will be presented.

Subsection Nd—Dentistry

Subsection Nd plans symposia cosponsored by the *International Association for Dental Research* and others.

Subsection Np—Pharmacy

Subsection Np is scheduling sessions for contributed papers and symposia, cosponsored by four to six national pharmaceutical societies.

O—Agriculture

Section O is planning four groups of invited papers on "Agricultural problems of the Far West" as follows: "Soil management problems in western agriculture," H. B. Cheney, chairman; "Water supplies and irrigation," F. J. Veihmeyer, chairman; "Seed production in the western states," J. G. Parsons, chairman; and "Problems in vegetable crops," J. E. Knott, chairman.

P—Industrial Science

Section P will have a round-table conference and a luncheon.

Q—Education

Section Q will have two sessions for contributed papers; joint sessions with the *American Educational Research Association*, with the *International Council for Exceptional Children*, and with the *Third Berkeley Symposium on Mathematical Statistics and Probability*; and the vice presidential address by George C. Kyte. The *AAAS Cooperative Committee on the Teaching of Science and Mathematics* is scheduling a symposium. The *National Science Teachers Association*, with Robert Stollberg as program chairman, is arranging sessions for invited papers at its regional meeting. The buffet supper and mixer for all science teachers will be Dec. 27.

X—Science in General

At its annual meeting, the *Academy Conference* will arrange for a round-table conference and a dinner. The *American Geophysical Union* will cosponsor appropriate programs. Under the program chairmanship of Ruth E. Hopson, the *American Nature Study Society*, at its national meeting, joint with its Western Division, is planning sessions for invited papers, panels, and its annual presidential address. The *California Academy of Sciences* will participate in the AAAS meeting in various ways. Again, for the third time, Mrs. Marian Fineman will arrange several sessions for the *Conference on Scientific Editorial Problems*. A business meeting, and perhaps a session, will be held by the *Honor Society of Phi Kappa Phi*. At its regular meeting, the *National Association of Science Writers* will have a symposium. It is probable that the *Sierra Club* will have joint sessions with the ANSS. The *Society of the Sigma Xi* and the *Scientific Research Society* will sponsor evening addresses on Dec. 29 and 30, respectively, and will hold their annual conventions with the Association on December 30, morning and afternoon, respectively. The *National Geographic Society* and the *United Chapters of Phi Beta Kappa* will arrange evening addresses, the latter scheduled for Dec. 27. The *Pacific Science Board* will sponsor an afternoon address.

RAYMOND L. TAYLOR
Associate Administrative Secretary

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(Note: In all divisions of this index, the letter (L) following a title indicates a letter to the editor.)

Title Index of Articles and Letters

Analytic Subject Index

Author Index

Books Reviewed

New Books Received

Dynamic and Abnormal Psychology. W. S. Taylor. New York: American Book, 1954. xiv + 658 pp. $5.50.

The Development of Negro Religion. Ruby F. Johnston. New York: Philosophical Library, 1954. 202 pp. Illus. $3.00.

Viruses. Cold Spring Harbor Symposia on Quantitative Biology, Vol. XVIII. Cold Spring Harbor, N.Y.: The Biological Laboratory, 1953. xvi + 301 pp. Illus. $8.00.

The Cyclotron. 4th ed. W. B. Mann. London: Methuen; New York: Wiley, 1953. xiv + 118 pp. Illus. $2.00.

Intertidal Invertebrates of the Central California Coast. S. F. Light's *Laboratory and Field Text in Invertebrate Zoology*, rev. by Ralph I. Smith *et al.* Berkeley: Univ. of California Press, 1954. xiv + 446 pp. Illus. $5.00.

The Actinide Elements. Glenn T. Seaborg and Joseph J. Katz, Eds. New York: McGraw-Hill, 1954. xxx + 870 pp. Illus. $11.75.

A Treasury of Science. 3rd ed. Harlow Shapley, Samuel Rapport, and Helen Wright, Eds. New York: Harper, 1954. xii + 724 pp. $5.95.

Ancient History of Western Asia, India and Crete. Bedřich Hrozný. Trans. by Jindřich Procházka. New York: Philosophical Library, 1953. xiv + 260 pp. Illus. + plates + maps. $12.00.

Symbolic Logic. Irving M. Copi. New York: Macmillan 1954. xiii + 355 pp. $5.00.

Wild Flowers of Western Pennsylvania and the Upper Ohio Basin, Vols. I and II. Text by O. E. Jennings, watercolors by Andrey Avinoff. Pittsburgh: Univ. of Pittsburgh Press, 1953. Vol. I, text, lxxv + 575 pp. + 150 maps. Vol. II, xvi + 200 color plates + explanations. $60.00 the set.

Microwave Spectroscopy. M. W. P. Strandberg. London: Methuen; New York: Wiley, 1954. vii + 140 pp. Illus. $2.50.

Treatise on Invertebrate Paleontology. Raymond C. Moore, Ed. Part G, *Bryozoa.* Ray S. Bassler. Lawrence, Kan.: Univ. of Kansas Press, 1953. 253 pp.

Cults and Creeds in Graeco-Roman Egypt. Being the Forwood Lectures for 1952. H. Idris Bell. New York: Philosophical Library, 1953. x + 117 pp. $4.75.

Biological Effects of External X and Gamma Radiation, Part I. Raymond E. Zirkle, Ed. McGraw-Hill, New York–London, 1954. xxvi + 530 pp. Illus. $7.25.

A History of the Theories of Aether and Electricity. The modern theories, 1900–1926. Sir Edmund Whittaker. Philosophical Library, New York, 1954. xi + 319 pp. $8.75.

A History of the College of Pharmacy, Columbia University. Charles W. Ballard. Columbia Univ. Press, New York, 1954. vii + 89 pp. Plates. $2.00.

Psychology: The Unity of Human Behavior. Timothy J. Gannon. Ginn, New York–London, 1954. xii + 482 pp. Illus. $4.75.

The Collected Papers of Stephen P. Timoshenko. (In German, French, and English.) McGraw-Hill, New York–London, 1953. xxv + 642 pp. Illus. $15.00.

Interlingua a Prima Vista. Alexander Gode. Storm, New York, 1954. 79 pp. Illus. $2.00.

Understanding the Japanese Mind. James Clark Moloney. Philosophical Library, New York, 1954. xviii + 252 pp. $3.50.

Power of Words. Stuart Chase. Harcourt Brace, New York. 1954. xii + 308 pp. $3.95.

Pattern of the Tiger. Stanwell Fletcher. Little, Brown, Boston, Mass., 1954. 296 pp. Illus. $5.00.

Symbolic Wounds. Puberty rites and the envious male. Bruno Bettelheim. Free Press, Glencoe, Ill., 1954. 286 pp. $4.75.

Elements of Statistics. H. C. Fryer. Wiley, New York; Chapman & Hall, London, 1954. xiii + 262 pp. Illus. $4.75.

1954 Medical Progress. A review of medical advances during 1953. Morris Fishbein, Ed. Blakiston, New York, 1954. x + 345 pp. $5.00.

Plant Growth Substances. L. J. Audus. Leonard Hall, London; Interscience, New York, 1953. xix + 465 pp. Illus. + plates. $6.50.

In Quest of a New Ethics. Charles Mayer. Beacon Press, Boston, 1954. xiii + 321 pp. $4.00.

Man, Rockets and Space. Burr W. Leyson. Dutton, New York, 1954. 188 pp. Illus. $3.50.

Fresh Water from the Ocean. Cecil B. Ellis. Ronald Press, New York, 1954. xi + 217 pp. Illus. $5.00.

Number: The Language of Science. 4th ed. A critical survey written for the cultured non-mathematician. Tobias Dantzig. Macmillan, New York, 1954. ix + 340 pp. $5.00.

Sex Determination. 3rd ed. F. A. E. Crew. Methuen, London; Wiley, New York, 1954. vii + 68 pp. $1.50.

Psychosomatic Case Book. Roy R. Grinker and Fred P. Robbins. Blakiston, New York, 1954. xiii + 346 pp. $6.05.

The Challenge of Man's Future. An inquiry concerning the condition of man during the years that lie ahead. Harrison Brown. Viking Press, New York, 1954. xii + 290 pp. Illus. $3.75.

Tissue Culture. 2nd ed. The growth and differentiation of normal tissues in artificial media. E. N. Willmer. Methuen, London; Wiley, New York, 1954. xx + 175 pp. Illus. + plates. $2.25.

Guidance and Counseling. With psychometric practices: A basic treatment. Lester Nicholas Recktenwald. Catholic Univ. Press, Washington, D. C., 1953. xiv + 192 pp. Paper, $2.50.

Las Dimensiones de la Cultura. Historia de la Etnologia en los Estados Unidos Entre, 1900 Y 1950. Charles Erasmus. Editorial Iqueima, Bogata, 1953. viii + 198 pp. $2.00.

Europe and America Since 1492. Western civilization and its world influence. Geoffrey Brunn and Henry Steele Commager. Houghton Mifflin, Boston, 1954. xiv + 907 pp. Illus. + maps. $6.75.

Introductory College Mathematics. Adele Leonhardy. Wiley, New York; Chapman & Hall, London, 1954. ix + 459 pp. Illus. $4.90.

The Rise of Methodism: A Source Book. Richard M. Cameron. Philosophical Library, New York, 1954. xv + 397 pp. $4.75.

The Natural History of Mammals. François Bourlière. Trans, by H. M. Parshley. Knopf, New York, 1954. xxi + 363 pp. Illus. + plates. $5.00.

An Introduction to Political Philosophy. A. R. M. Murray. Philosophical Library, New York, 1953. vii + 240 pp. $4.75.

TRAVEL ARRANGEMENTS FOR THE AAAS BERKELEY MEETING

December 26-31, 1954

In time or in cost, a trip from an eastern city to California is not much more than a **round trip** to a midwestern city. Californians who for years have been attending meetings in the East have told their colleagues that the continental distance is the **same** each way, and that it should be the turn of the Easterners to visit the Pacific Coast.

The Association is planning ways it may assist those who will attend the 121st AAAS Meeting on the campus of the University of California at Berkeley, this December. The possibilities include:

1. Low cost AAAS limousines from Oakland and San Francisco airports and railroad terminals direct to the dormitory or hotel of each delegate.
2. Arrangements for traveling together in AAAS cars on fast trains leaving Chicago, Washington, D. C., and New York.
3. Arrangements for chartering first class DC6, 6B, or 7 planes of scheduled airlines—at prices comparable with air coach travel.

Note: In the following table of **round-trip** fares all figures include the new lowered 10% federal tax.

ROUND TRIPS TO OAKLAND OR SAN FRANCISCO FROM

	Chicago	Washington, D. C.	New York
By Bus	Time: 2½ days $82.50	Time: 4 days $104.94	Time: 4 days $112.31
By Rail	Time: 2½ days — leaving evening, Dec. 24 and morning, Dec. 31	Time: 3½ days — leaving evening, Dec. 23 and morning Dec. 31	Time: 3½ days — leaving evening, Dec. 23 and morning Dec. 31
Reclining seat coach	$ 99.17	$147.62	$156.64
First class	$139.10	$204.33	$222.67
Lower berth	46.20	60.06	63.58
Total	$185.30	$264.39	$286.25
By Air	Time: 7–8 hrs., leaving a.m. or p.m., Dec. 26; returning a.m. or p.m. Dec. 31	Time: 10–11 hrs., leaving a.m. or p.m., Dec. 26; returning a.m. or p.m., Dec. 31	Time: 10–11 hrs., leaving a.m. or p.m., Dec. 26; returning a.m. or p.m., Dec. 31
Air coach (no meals)	$167.20	$215.60	$217.80
Chartered 1st class (meals included)	c. $178.00	c. $235.00	c. $235.00
First class (meals included)	$239.91	$312.18	$332.09

PLEASE READ ABOVE TABLE, FILL OUT THIS COUPON, AND SEND IT TO

AAAS TRAVEL — Dr. R. L. Taylor
1515 Massachusetts Avenue, N.W.
Washington 5, D. C.

Name ....

Address ....

I shall probably attend the AAAS Meeting in Berkeley. Without obligation I am interested in possible group travel arrangements to San Francisco from:

1. ☐ Chicago ☐ Washington, D. C. ☐ New York ☐ Other city: ....
2. My preferred manner of transport is:
   ☐ Rail — coach ☐ Air — coach ☐ Bus
   ☐ Rail — 1st class ☐ Air — chartered, 1st class ☐ Other
   ☐ Air — 1st class
3. I would ☐ return east immediately after the meeting
   ☐ like to make a side trip to ....
   ☐ remain indefinitely on the Pacific Coast

Meetings

June

21–25. American Inst. of Electrical Engineers, summer general and Pacific general, Los Angeles, Calif. (H. H. Henline, 33 W. 39 St., New York 18.)

21–25. American Medical Assoc., annual, San Francisco, Calif. (AMA Office, 535 N. Dearborn St., Chicago 10, Ill.)

21–25. Symposium on Impact of Solid State Science on Engineering Materials, Pittsburgh, Pa. (J. W. Graham, Jr., College of Engineering, Carnegie Inst. of Technology, Pittsburgh 13.)

21–25. Technical Writers' Inst., 2nd annual, Troy, N. Y. (J. R. Gould, Rensselaer Polytechnic Inst., Troy.)

22–24. American Dairy Science Assoc., 49th annual, State College, Pa. (J. O. Almquist, College of Agriculture, Pennsylvania State Univ., State College.)

22–24. Oceanographic Convocation, Woods Hole, Mass. (H. R. Gault, National Research Council, Washington 25, D.C.)

22–25. Rubber Technology Conf., 3rd, London, England. (Sec., Institution of Rubber Industry, 12, Whitehall, London S.W.1.)

23–25. Cong. for the Advancement of Spectrographic Methods, 17th, Paris, France. (Sec., G.A.M.S., 1, Place St. Thomas d'Aquin, Paris 7.)

23–26. Acoustical Soc. of America, 25th, New York, N. Y. (W. Waterfall, 57 E. 55 St., New York 22.)

25–29. Inst. of Aeronautical Sciences, New York, N. Y. (S. P. Johnston, 2 E. 64 St., New York City.)

27–1. Inst. of Food Technologists, annual, Los Angeles, Calif. (C. S. Lawrence, 176 W. Adams St., Chicago 3, Ill.)

28–29. National Science Teachers Assoc., New York, N. Y. (R. H. Carleton, 1201 16 St. NW, Washington 6, D. C.)

28–30. American Assoc. of Physics Teachers, Minneapolis, Minn. (R. F. Paton, Univ. of Illinois, Urbana.)

28–30. American Physical Soc., Minneapolis, Minn. (K. K. Darrow, Columbia Univ., New York 27.)

28–30. American Soc. of Heating and Ventilating Engineers, 60th semiannual, Swampscott, Mass. (Sec., ASHVE, 62 Worth St., New York 13.)

28–2. European Cong. of Gastroenterology, 4th, Paris, France. (A. Busson, 63 bis, Rue de Varenne, Paris 7.)

28–3. National Education Assoc., annual, New York, N. Y. (L. W. Ashby, 1201 16 St. NW., Washington 6, D. C.)

30–2. Heat Transfer and Fluid Mechanics Inst., Berkeley, Calif. (H. A. Johnson, Dept. of Mechanical Engineering, Univ. of California, Berkeley.)

July

1–9. British Medical Assoc., Glasgow, Scotland. (BMA, Tavistock Sq., London, W.C.1.)

2–8. International Cong. of Oto-Neuro-Ophthalmology, 19th, São Paulo, Brazil. (C. de Rezende, Hospital das Clinicas, Av. Ademar de Barros, São Paulo.)

2–14. International Cong. of Botany, 8th, Paris, France. (P. Chouard, 11, rue de Val-de-Grace, Paris 5.)

6–9. American Home Economics Assoc., San Francisco, Calif. (M. Horton, 1600 20 St., NW, Washington, D.C.)

7–10. American Physical Soc., Seattle, Wash. (J. Kaplan, Univ. of California, Los Angeles.)

8–9. International Union of Pure and Applied Physics, 8th, London, Eng. (H. A. Barton, 57 E. 55 St., N[illegible] York 22.)

8–12. Convention on Industrial Electronics, Oxford, E[illegible] (Sec., British Inst. of Radio Engineers, 9 Bedford [illegible] London, W.C.1.)

10–15. Latin American Cong. on Gynecology and O[illegible]stetrics, 2nd, São Paulo, Brazil. (J. Ramos, Av. Bri[illegible]deiro Luiz Antonio, 278–80, São Paulo.)

11–14. American Soc. of Refrigerating Engineers, Seat[illegible] Wash. (M. C. Turpin, 234 5 Ave., New York 1.)

13–17. Conf. on Defects in Crystalline Solids, Bris[illegible] Eng. (H. A. Barton, 57 E. 55 St., New York 22.)

13–17. Cong. on Experimental and Theoretical Nucl[illegible] Physics, Glasgow, Scotland. (H. A. Barton, 57 E. [illegible] St., New York 22.)

15–17. International Symposium on Solid Particles in A[illegible]tronomical Objects, Liége, Belgium. (P. Swings, Ins[illegible]tut d'Astrophysique, Cointe-Sclessin, Belgium.)

15–21. Pan American Cong. of Child Welfare and Pe[illegible]atrics, 4th, São Paulo, Brazil. (J. Ramos, Av. Brigade[illegible] Luiz Antonio 278–80, São Paulo.)

16–21. International Conf. on Electron Microscopy, Lo[illegible]don, Eng. (F. W. Cuckow, Royal Cancer Hospit[illegible] London, S.W.3.)

17–22. Latin American Cong. on Mental Health, 1st, Sã[illegible] Paulo, Brazil. (A. C. Pacheco e Silva, Av. Brigadei[illegible] Luiz Antonio 651, São Paulo.)

19–23. International Cong. of Gerontology, 3rd, Londo[illegible] Eng. (International Assoc. of Gerontology, 660 [illegible] Kingshighway, St. Louis 10, Mo.)

19–24. Pan American Cong. on Gastroenterology, 5t[illegible] São Paulo, Brazil. (J. Ramos, Av. Brigadeiro Luiz A[illegible]tonio 278–80, São Paulo.)

19–31. French Assoc. for the Advancement of Scienc[illegible] Poitiers, France. (FAAS, 28 Rue Serpente, Paris 8.)

20–24. International Conf. on Thrombosis and Embolism[illegible] Basel, Switzerland. (W. Merz, Gynecological Clini[illegible] Univ. of Basel.)

21–24. International Cong. of Medical Psychotherapy[illegible] Zurich, Switzerland. (H. K. Fiers-Monnier, Haupt[illegible]strasse 9, Kreuzlingen, Switzerland.)

21–28. International Cong. of Crystallography, 3rd, Paris[illegible] France. (J. D. H. Donnay, Johns Hopkins Univ., Bal[illegible]timore, Md.)

23–29. International Cancer Cong., 6th, São Paulo[illegible] Brazil. (H. L. Stewart, National Cancer Inst., Bethesda[illegible] 14, Md.)

25–31. Inter-American Cong. of Sanitary Engineering[illegible] 4th, São Paulo, Brazil. (L. Nogueira, Caixa Postal [illegible] 8099, São Paulo.)

25–8. World Power Conf., sectional, Rio de Janeiro[illegible] Brazil. (C. R. Farina, Av. Presidente Vargas 642, Ri[illegible] de Janeiro.)

26–31. International Cong. of Gynecology and Obstetrics[illegible] Geneva, Switzerland. (W. Geisendorf, Maternite, Hopi[illegible]tal Cantonal, Geneva.)

27–28. International Union of Theoretical and Applied [illegible] Mechanics, 4th, Brussels, Belgium. (H. L. Dryden, 1724 F St., NW, Washington 25, D.C.)

28–2. International Union for the Protection of Nature[illegible] 4th, Copenhagen, Denmark. (H. J. Coolodge, National [illegible] Research Council, Washington 25, D.C.)

28–2. Symposium on Photoelasticity and Photoplasticity[illegible] Brussels, Belgium. (H. L. Dryden, 1724 F St., NW[illegible] Washington 25, D.C.)

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